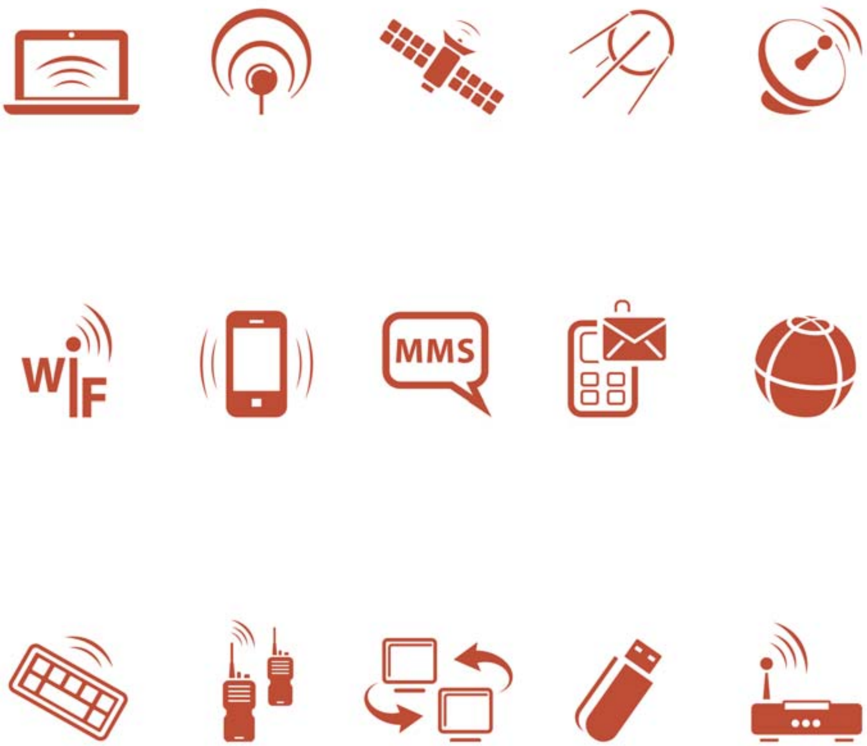
Technology, Media & Telecom

Mobility 2020

How An Increasingly Mobile World Will Transform TMT Business Models Over the Coming Decade

Jefferies

Global TMT Equity Research



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Portfolio Managers' Summary

"Mobility 2020" leverages the experience and insight of 25 Jefferies TMT analysts based in Hong Kong, London, New York, San Francisco and Tokyo. In this study, analysts collaborated to contemplate the implications of mobility over the coming years as it relates to their sectors and their stock coverage.

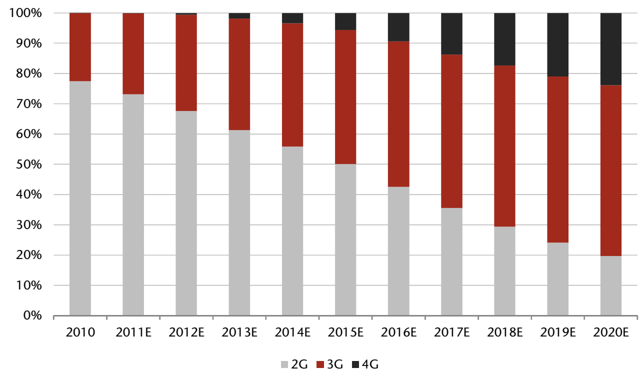
Multiple trends centered around mobility – including higher wireless bandwidth, the immediacy of social networking and advances in devices – are transforming the full technology, media and telecommunications food chain: handset, tablet and other hardware manufacturers; telecommunications service providers, network infrastructure and semiconductor vendors, and developers of end-user software, content, and payment systems.

To cite but a few illustrative examples:

- On a global basis, we estimate that 80% of mobile devices in use will be 3G/4G by 2020, up from 27% this year. In addition to 6.1 billion 3G/4G subscribers globally by 2020, we anticipate tablet sales to rise from 70 million this year to over half a billion in 2020. Most of these tablets will connect wirelessly via 3G/4G and/or WiFi/WiMax.
- According to a recent Cisco (CSCO, $15.67, Hold) study, mobile data is expected to grow over 2500% by 2015 from 2010 levels, the highest rate of all types of IP (Internet protocol) traffic. By the end of 2015, consumers are expected to be generating 4.9 exabytes of mobile IP data monthly, and businesses 1.3 exabytes.
- Social media is a major driver of mobile usage growth. In the last year alone, total monthly minutes spent on social networking sites has grown nearly 50%, and total monthly unique visitors to social networking sites is over 200 million.
- In just three years, the number of "apps" available for download for Apple's (AAPL, $384.83, Buy) revolutionary mobile devices such as the iPhone and iPad has grown from 500 to 500,000, and has in the process transformed user software adoption and usage trends.

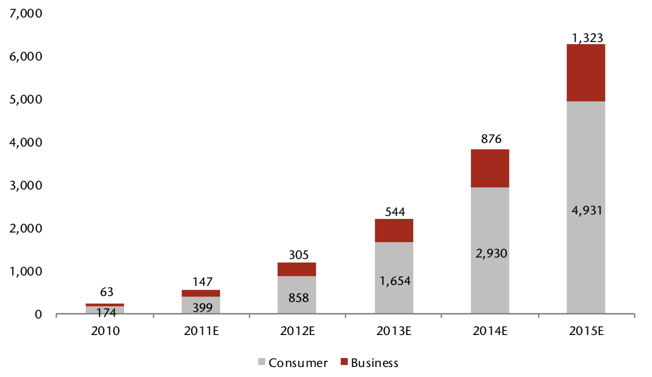
Note: Companies mentioned in this report are priced as of the August 31, 2011, market close.

Exhibit 1: 80% of Mobile Devices In Use Will Be 3G/4G by 2020, Up From 27% This Year



Source: Jefferies & Co. estimates.

Exhibit 2: Mobile Data and Internet Growth – Consumer and Business, 2010-2015E (in petabytes of data per month)



Source: Cisco Visual Networking Index, June 2011.

Exhibit 3: Mobile Data and Internet Usage by Application, 2010-2015E

	2010	2011E	2012E	2013E	2014E	2015E
Consumer Web & Data	54	119	241	426	685	1,084
Consumer File Sharing	25	49	88	138	206	310
Consumer Gaming	2	4	10	19	34	76
Consumer Voice-over-IP	3	5	7	9	12	20
Consumer Video Communications	4	9	17	31	52	97
Consumer Internet Video	85	213	493	1,028	1,933	3,333
Business Mobile Data	63	147	305	543	876	1,323

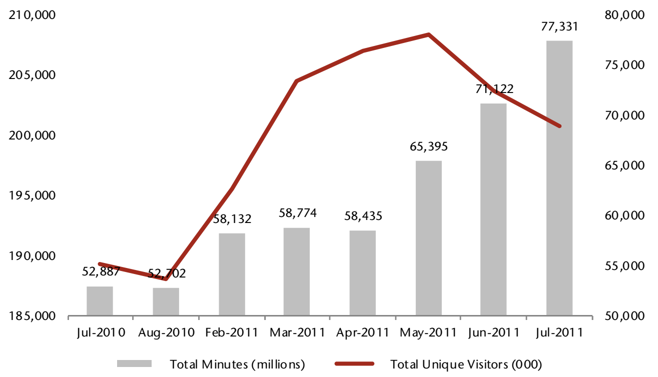
Source: Cisco Visual Networking Index, June 2011.

Exhibit 4: Mobile Data and Internet Usage by Geography, 2010-2015E

	2010	2011E	2012E	2013E	2014E	2015E
North America	49	118	235	416	675	986
Western Europe	64	146	326	635	1,073	1,632
Asia Pacific	55	128	269	530	997	1,837
Japan	40	86	172	289	425	578
Latin America	12	26	60	127	257	488
Central & Eastern Europe	10	25	56	110	201	346
Middle East & Africa	6	17	44	90	179	387

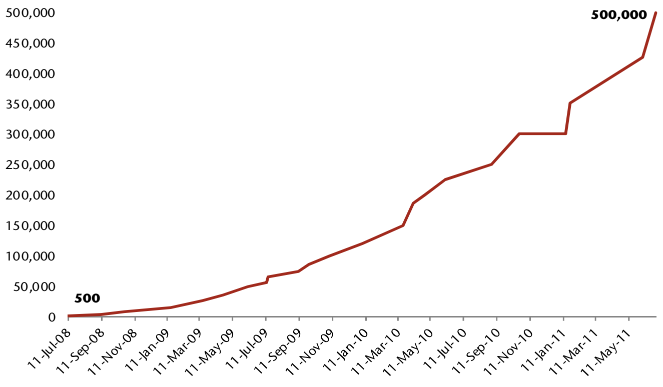
Source: Cisco Visual Networking Index, June 2011.

Exhibit 5: Social Media Minutes of Use and Monthly Unique Visitors



Source: ComScore.

Exhibit 6: Available Apple "Apps" – From 500 to 500,000 in Three Years



Source: Apple; Jefferies & Co. estimates.

Jefferies Global Mobile Device Forecast

Following are highlights of our global mobility forecasts. Our full industry models appear as an appendix at the end of this report.

7.6 billion mobile users are expected by 2020, up 41% from 5.4 billion today. The largest area of expansion is expected to be Asia, anticipated to grow 68% from 2.6 billion subscribers today. We anticipate Asia will represent 57% of total global users by 2020; Europe 13%; and North America 5%.

Jefferies expects the number of handsets sold globally on an annual basis to reach 3.1 billion by 2020, up from 1.7 billion currently. This represents 7% compound annual growth in global devices (and 94% absolute growth) from 2010 to 2020. This includes a CAGR of 2% in North America, 4% in Europe, 9% in Asia, and 5% in Latin America.

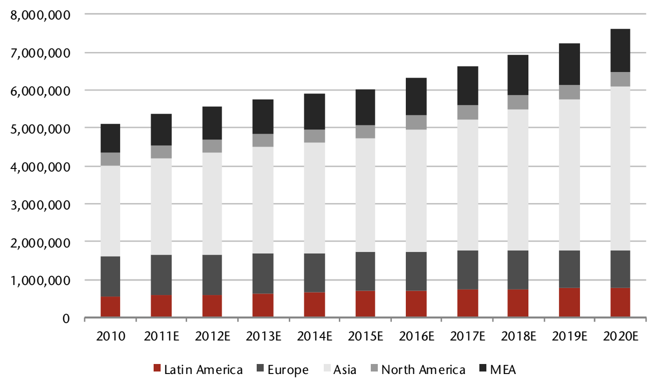
"Smartphones" will continue to replace feature phones globally. We anticipate a 23% CAGR in smartphones sold through 2020, versus a decline of 8% in other units. By 2020, we anticipate 81% of units sold globally will be smartphones, from 26% today. This translates into 2.5 billion smartphone units sold globally in 2020, up from 0.4 billion this year.

User connectivity via tablets will also be a major factor that will increasingly impact the full spectrum of TMT companies. We forecast global shipments of 595 million tablets in 2020 versus a forecast of 70 million in 2011. Apple is the leader (in terms of both form factor and technology) in this market. As the market widens, Apple's tablet share of shipments is forecast to drop from 64% in 2011 to 34% by 2020.

Wireless penetration is forecast to reach 99% of the global population by 2020, up from 87% today. This includes 103% penetration in North America, 134% in Europe, 101% in Asia, 70% in MEA, and 119% in Latin America. Some geographies will see well north of 100% penetration due to the existence of prepaid subscribers, subscribers with multiple SIM cards, and users with more than one device (such as a phone for work and a personal phone).

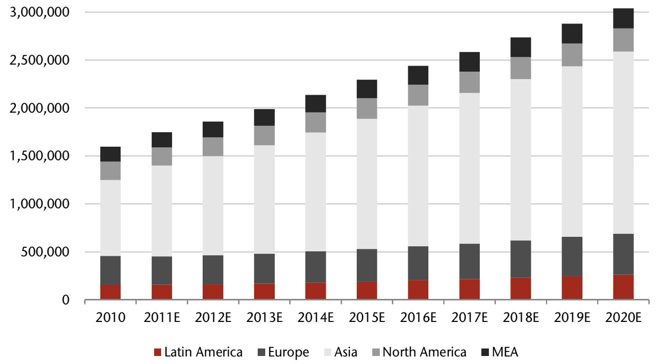
By 2020 we anticipate 3G and 4G will represent 99% units sold, up from 53% in 2011. By 2015 we estimate half of the global subscriber base will be on 3G/4G networks, and 3G/4G handsets should be 80% of the subscriber base by 2020 – up from 27% today. Japan and North America are well ahead of the rest of the world in advanced technology adoption, and currently boast 3G/4G penetration of 87% and 99%, respectively, by our estimates.

Exhibit 7: Worldwide Mobile Subscribers, 2010-2020E



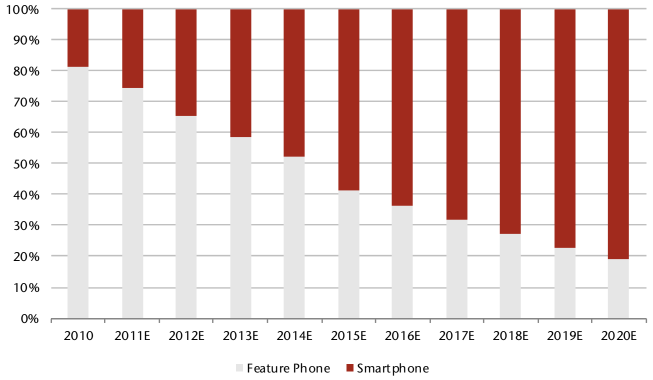
Source: Jefferies & Co. estimates.

Exhibit 8: Mobile Handsets Sold Annually, 2010-2020E (000s)



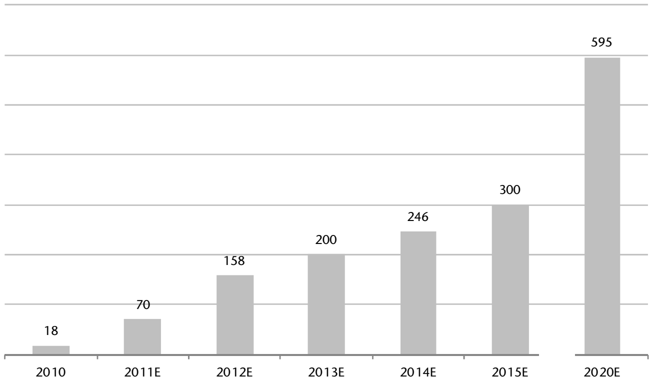
Source: Jefferies & Co. estimates.

Exhibit 9: Sales of Smartphones vs. Feature Phones, 2010-2020E



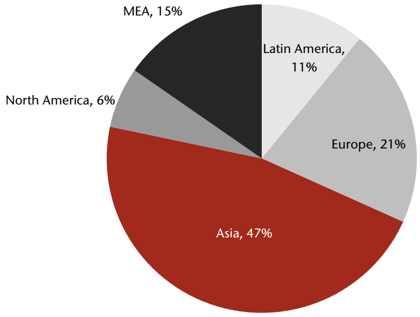
Source: Jefferies & Co. estimates.

Exhibit 10: Tablets Sold Annually, 2010-2020E (in millions)



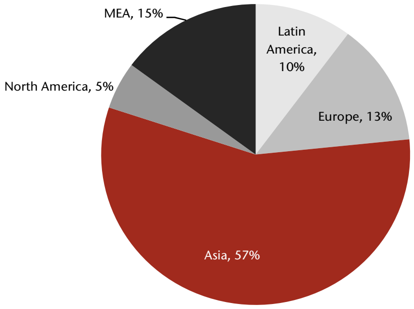
Source: Jefferies & Co. estimates.

Exhibit 11: Percentage of Worldwide Mobile Subscribers, 2010



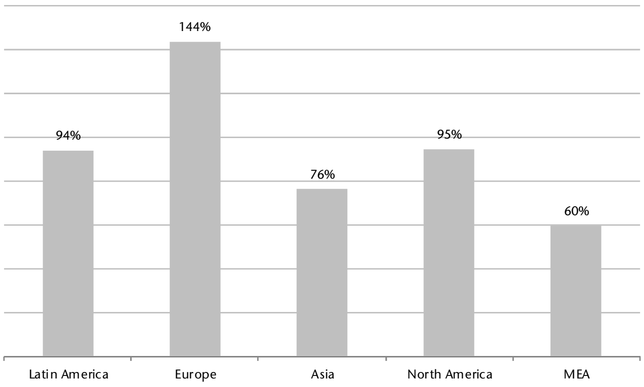
Source: Jefferies & Co. estimates.

Exhibit 12: Percentage of Worldwide Mobile Subscribers, 2020E



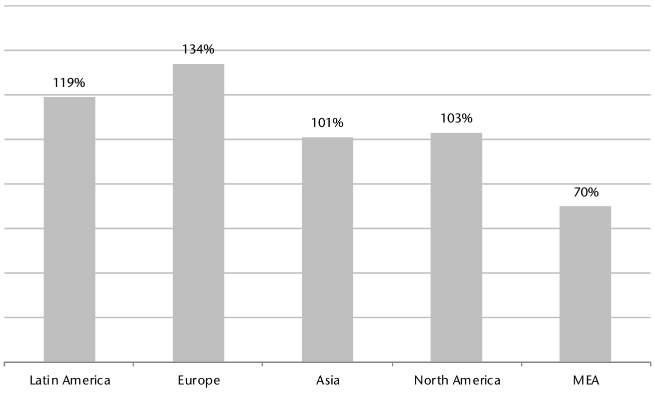
Source: Jefferies & Co. estimates.

Exhibit 13: Mobile Penetration by Geography, 2010



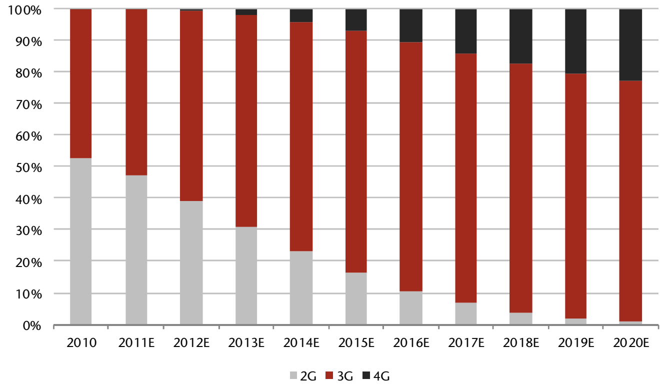
Source: Jefferies & Co. estimates.

Exhibit 14: Mobile Penetration by Geography, 2020E



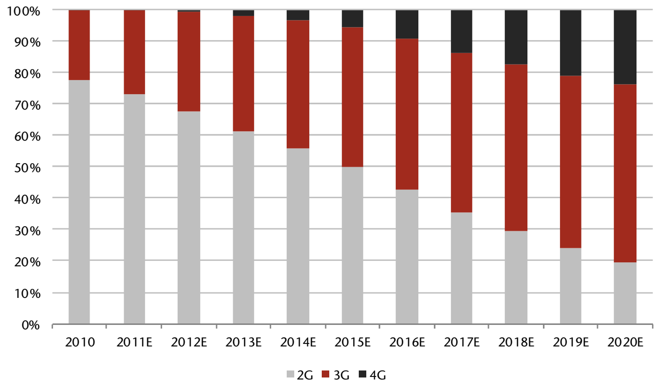
Source: Jefferies & Co. estimates.

Exhibit 15: Technology Mix of Handsets Sold, 2010-2020E



Source: Jefferies & Co. estimates

Exhibit 16: Technology Mix of Installed Handset Base, 2010-2020E



Source: Jefferies & Co. estimates

The Mobile World: Challenges & Opportunities Across the Full TMT Spectrum

The nature of mobile devices and their capabilities continues to unfold, bringing challenges and opportunities for technology, media and telecommunications companies. This report discusses the transitions that these organizations will face over the next decade, as well as our predictions for specific long-term beneficiaries and those with secular challenges.

- **Form factor: What mobile devices will look like, and what key features will be added** (Peter Misek, Lee Simpson, and Cynthia Meng). Form factor and feature sets are key components of mobile device evolution. We believe advances in battery technologies are crucial to the industry and highlight carbon nanotube as a promising technology. We foresee that gesture- and voice-based controls and pico (miniature) projection will also be among the technologies offered to the consumer over the next decade. We forecast that OLED technology will provide the flexibility to display data virtually anywhere, including walls, watches or even clothing. Finally, we highlight the possibility of real-time ray-tracing graphics capabilities. **AAC Technologies** (2018 HK, HK$16.54, Buy), **ASM International** (ASM NA, €18.47e, Hold), **Imagine Technologies** (IMG LN, 354.60p, Buy), **NXP Semiconductors NV** (NXPI, $16.29, Buy) and **Universal Display Corporation** (PANL, $49.06, NC) are highlighted as participating in these emerging technologies.

- **What the bandwidth requirements will be given anticipated demand, and how telecommunications service delivery and revenue models will evolve to meet changing end-user needs** (Jerry Dellis, Cynthia Meng, Tom Seitz, and Ulrich Rathe). In our view, mobile data is unlikely to re-rate the telecom share of wallet, except in countries where fixed broadband penetration is low. Voice/messaging will remain deflationary in developed markets. We are skeptical that escalating bandwidth demand will confer sustainable pricing power, other than for networks with a clear quality advantage. Cannibalization risk to legacy revenue should drive migration to integrated bundles. But a side effect of this will be more transparent pricing, something the industry historically sought to avoid. We see potential disruption to market structures with user behavior powerfully shaped by attraction to specific smartphones and operators likely to be rapidly appraised on the quality of the devices/connectivity they offer. Significant beneficiaries, in our view, will be **Vodafone** (VOD LN, 161.00p, Buy) (in Europe, and VZW in the US) and **China Unicom** (762 HK, HK$16.28, Buy, Buy).

- **What the infrastructure and component requirements required to support the devices and applications envisioned will be** (Mark Lipacis, Sundeep Bajikar, Andrej Krneta, Rob Lea, Cynthia Meng, Lee Simpson, George Notter, James Kisner and Masahiro Wakasugi). We forecast mobile data bandwidth demand will grow by at least 100x by 2020. This massive growth has significant implications for network infrastructure equipment and the semiconductor content within this hardware. Carriers will use a variety of techniques to handle massive growth in bandwidth demand, but there is no silver bullet, in our view. We think operators will use a combination of tools to manage growth, including acquiring new spectrum, deploying more efficient wireless technologies/algorithms like LTE and LTE Advanced, and aggressive use of cell splitting. Other techniques include the more aggressive use of tiered mobile data pricing plans. We further see wireless RAN (regional area network) infrastructure changing dramatically. Operators will have to deploy large numbers of small form factor RAN devices to accommodate bandwidth growth, and WiFi/WiMax will also become an important part of the solution. We forecast that LTE will be the dominant air interface for the installed base of subscribers in 2020. We see **Alcatel-Lucent** (ALU FP, €2.62, Buy), **Broadsoft** (BSFT, $30.25, Buy), **Juniper** (JNPR, $20.93, Buy), and **Tekelec** (TKLC, $7.20, Hold) as significant beneficiaries of the pending transformation within wireless networks. We also see **ZTE Corp.** (763 HK, HK$21.50, Buy) as a long term winner in telecommunications infrastructure. We also anticipate a dramatically higher level of mobility in 2020 to drive semiconductor growth across three broad classes of end markets: Mobile Terminals, the Cloud/Data Center, and the Communications Infrastructure that connects those two end points of the network. Our top mobile terminal picks are **Avago** (AVGO, $33.11, Buy), **Broadcom** (BRCM, $35.65, Buy) and **Murata** (6981 JP, ¥4680, Buy). Our data center/cloud semiconductor plays are **Intel** (INTC, $49.33, Buy), **AMD** (AMD, $6.83, Hold) and **PMC-Sierra** (PMCS, $6.09, Buy), and our communications infrastructure picks are **Altera** (ALTR, $36.39, Buy), **Inphi** (IPHI, $8.04, Buy) and **NetLogic** (NETL, $30.02, Buy).

- **The rise of "apps," and how the software operating model will change as a result of anticipated evolution of devices** (Ross MacMillan, Aaron Schwartz, Milan Radia, Daniel Morris and Graeme Clark). The software operating model is changing as a result of mobility in a number of ways. First, we think Software as a Service (SaaS) and cloud computing are extending applications for free to mobile devices in an easy and natural way, whereas traditional client server applications are at a disadvantage with vendors seeking to charge for extensions to mobile devices. Second, mobility is changing the enterprise application itself and a combination of real-time data and analytics, location-based services and social applications are reshaping the functionality of what applications provide. Machine to machine (M2M) connectivity is also creating new software opportunities. Finally, app stores have changed the distribution and pricing model for software, which is having a near-term impact on traditional vendors. We think **Salesforce.com** (CRM, $128.75, Buy), **Qlik Technologies** (QLIK, $25.38, Hold), **Symantec** (SYMC, $17.15, Buy) and **Telecity** (TCY LN, pr545.50p, Hold) are well placed to benefit from mobility, while **Adobe** (ADBE, $25.24, Buy) and **Micro Focus** (MCRO LN, 312.00p, Hold) are challenged.

- **How end-user consumption of media content will evolve** (Nick Bell, Youssef Squali, David Reynolds, Naved Khan, and Will Smith). Mobile advertising is still nascent, but as the number of users and usage time per device grow, marketers will follow, in our view. We believe mobile is the ultimate mass market ad platform, given its scale, reach, targetability, engagement and analytics. U.S. mobile ad revenue will hit a major milestone in 2011 as it exceeds the $1B mark for the first time, based on eMarketer estimates, but as a percentage of total digital ad revenue, it is still less than 2%. By 2014, we expect that level to quadruple and by 2020, we believe that mobile will account for the majority of online ad revenue. We see **Google** (GOOG, $540.96, Buy) and Facebook as two companies particularly well positioned to benefit from this shift. Additionally, the explosion of Internet-enabled mobile devices empowers consumers to choose how, where, and when to consume content. This has the potential to dramatically change the media landscape, particularly for television broadcasters, the current video gatekeepers. Internet-enabled devices have already affected consumer behavior, with viewers migrating from traditional linear schedules to on-demand viewing. We see this trend as benefitting the likes of **Netflix** (NFLX, $235.01, Hold) and **BSkyB** (BSY LN, 695.50p, Hold). Finally, while the Internet's role in driving local commerce is still nascent today, this is rapidly changing, particularly with the adoption of highly targeted and more efficient models that both consumers and advertisers are embracing. We believe that mobile's growth will play a transformative role in driving local commerce given the ability to target in-market customers on the go via geo-targeted ads, smart e-commerce apps and payments platforms. This shift is likely to play into the hands of companies like **Amazon** (AMZN, $215.23, Buy) and **eBay** (EBAY, $30.87, Buy).

- **How payment systems will be rethought as mobile platforms and applications change** (Jason Kupferberg). Mobile payments at the physical point-of-sale (as opposed to mobile e-commerce purchases or peer-to-peer payments) remain the largest potential long-term mobile commerce opportunity by a significant margin, we believe. However, in the foreseeable future, we see this opportunity as being more fertile in less mature economies, which have less developed banking infrastructure. In developed markets such as the US, there have been many intriguing mobile payments trials and partnerships announced, but there remains a "chicken and egg" challenge of finding a mobile payments solution at the point of sale which appeals to both consumers and merchants. We believe a key driver of widespread mobile payments adoption in the US could be dynamic mobile marketing/advertising, and that a simple change in payments form factor (i.e., from card to phone) will likely not resonate in a significant way with either consumers or merchants. We do not expect traditional card networks such as **Visa** (V, $87.88, Buy) and **MasterCard** (MA, $329.71, Buy) to be disintermediated by mobile payments, as alternative providers (such as the telcos via their ISIS JV) have come to realize that there are ample barriers to entry in the payments business. Both V and MA have continued to actively invest in the mobile space for years via products and partnerships, and to the extent consumer/merchant adoption of this channel increases over time, we would expect V and MA to benefit.

Stock-Specific Conclusions

The table below summarizes the stocks we believe stand to enjoy secular benefits or that face secular headwinds from the trends outlined in this report. Note that this is a multi-year assessment while our ratings are based on a 12-month horizon. There may be other trends, risk factors or benefits that may influence our ratings and/or 12-month price targets.

Exhibit 17: Mobility 2020: Stocks That Face Secular Benefits & Headwinds

Company	Analyst	Symbol	Rating	Price	Price Target	Beneficiary/Headwind
AAC Technologies	Chen	2018 HK	Buy	HK$16.64	HK$17.55	Beneficiary
Adobe	MacMillan	ADBE	Buy	$25.24	$38	Headwind
Alcatel-Lucent	Notter	ALU FP	Buy	€2.62	€3.50	Beneficiary
Altera Corp.	Lipacis	ALTR	Buy	$36.39	$52	Beneficiary
Amazon.com	Squali	AMZN	Buy	$215.23	$250	Beneficiary
Advanced Micro Devices	Lipacis	AMD	Hold	$6.83	$7.50	Beneficiary
Apple	Misek	AAPL	Buy	$384.83	$500	Beneficiary
Avago Technologies	Lipacis	AVGO	Buy	$33.11	$45	Beneficiary
Broadcom	Lipacis	BRCM	Buy	$35.65	$46	Beneficiary
Broadsoft	Notter	BSFT	Buy	$30.25	$32	Beneficiary
BSkyB	Bell	BSY LN	Hold	695.50p	750p	Beneficiary
China Unicom	Meng	762 HK	Buy	HK$16.28	HK$21	Beneficiary
eBay	Squali	EBAY	Buy	$30.87	$43	Beneficiary
France Telecom	Dellis	FTE FP	Underperf	€12.07	€15.30	Headwind
Google	Squali	GOOG	Buy	$540.96	$830	Beneficiary
Imagination Tech	Simpson	IMG LN	Buy	354.60p	551p	Beneficiary
Inphi Corp.	Bajikar	IPHI	Buy	$8.04	$13	Beneficiary
Intel	Lipacis	INTC	Hold	$20.13	$25	Beneficiary
Juniper	Notter	JNPR	Buy	$20.93	$34	Beneficiary
Mastercard	Kupferberg	MA	Buy	$329.71	$384	Beneficiary
Micro Focus	Radia	MCRO LN	Hold	312.00p	320p	Headwind
Murata	Wakasugi	6981 JP	Buy	¥4680	¥6100	Beneficiary
Netflix	Squali	NFLX	Hold	$235.01	$265	Beneficiary
NetLogic Microsystems	Bajikar	NETL	Buy	$30.02	$49	Beneficiary
NXP Semiconductors NV	Lipacis	NXPI	Buy	$16.29	$24	Beneficiary
PMC-Sierra	Bajikar	PMCS	Buy	$6.09	$9.50	Beneficiary
Qlik Technologies	MacMillan	QLIK	Hold	$25.38	$34	Beneficiary
Salesforce.com	MacMillan	CRM	Buy	$128.75	$156	Beneficiary
Symantec	Schwartz	SYMC	Buy	$17.15	$23	Beneficiary
Tekelec	Notter	TKLC	Hold	$7.20	$7	Beneficiary
Telecity	Radia	TCY LN	Hold	545.50p	460p	Beneficiary
TeliaSonera AB	Rathe	TLSN SS	Underperf	SEK 44.58	SEK 44.00	Headwind
Visa	Kupferberg	V	Buy	$87.88	$102	Beneficiary
Vodafone plc	Dellis	VOD LN	Buy	161.00p	205p	Beneficiary
ZTE Corp.	Meng	763 HK	Buy	HK$21.50	HK$30	Beneficiary

Source: Jefferies & Co. estimates.

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The Evolution of Mobile Device Form Factors and Features

The Mobile Device of the Future

While devices are converging in function and increasingly becoming "all-in-one," we believe their form factors will differentiate them. For example, smartphones and tablets are almost identical technologically, especially when the tablet is connected to a network, but their form factors dictate differences in how and when the devices are used. Smartphones are great for mobile communication, email, and light Web browsing, and while powerful-enough and capable of much more, their small screen results in an inferior user experience for full-scale Web browsing and media consumption. Similarly, the extra screen real estate combined with a thin, lightweight body makes a tablet well-suited for rich media-consumption. We believe that in the future, users will choose devices by factors beyond just screen size, including flexibility, battery life, durability, weight, and disposability.

After tremendous advances in the miniaturization of mobile PC components, pocket-sized mobile devices are now capable of what desktop PCs were capable of not long ago. Though continuously getting smaller and slimmer, mobile devices have retained a fairly consistent form factor; smartphones, tablets, and other mobile devices are basically rectangular pieces of glass.

Herein we explore trends related to battery technologies and user interface breakthroughs (such as gesture-based controls, pico projection and voice-based controls). We also believe that advances in OLED displays will greatly increase our ability to create different form factors for smartphones, tablets, PCs, consumer electronic devices, advertisements, and even clothing.

Battery Life – Currently A Limiting Factor

A factor that will have a direct correlation with mobile feature set evolution will be battery technology. Photovoltaic cells and batteries based on other current technologies will not have an electron store that will keep pace with desired mobile device feature sets. Even with a potentially significant reduction in power consumption, new battery technologies must emerge that will allow for the full miniaturization and electron storage required.

The Issue

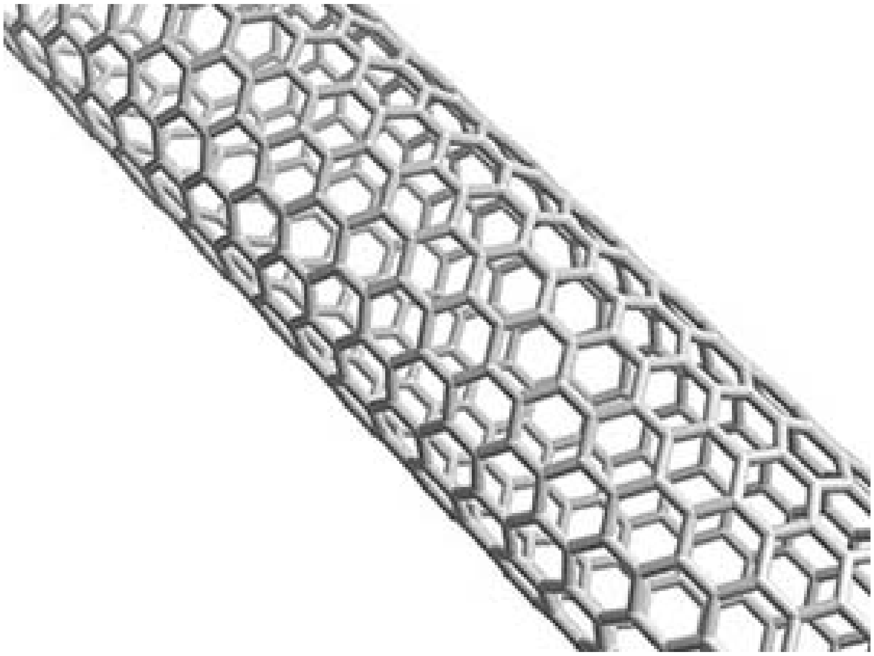
Much progress has been made in energy savings on portable devices via power management IC (integrated circuit, such as those developed by Dialog Semiconductor plc [DLG GR, €11.60, Buy]), processor efficiency (such as that developed by ARM Holdings [ARM LN, 478.70p, Underperform], and node shrink (ASML Holding NV [ASML NA, €22.95, Buy]). This progress has arguably been one of the most significant factors in the rapid rise of mobile computing and new portable form factors such as smartphones and tablets. Yet, battery technology has been a laggard. Some estimates put annual efficiency gain for Li-ion batteries at 11%, versus Moore's Law impact of doubling integration every 18 months. With ARM Holdings recently warning of an IC scaling slowdown as EUV's (extreme ultraviolet) yield continues to disappoint, the pressure on the battery research and development front is accelerating.

Specifically, Li-ion (lithium ion) batteries suffer from degradation as dissipated heat often impacts the ability of the battery supply to be fully recharged. A gradual decline in capacity to hold a charge develops as the formation of solid electrolyte interphase film increases internal resistance and prevents a full recharge of the battery pack. In the past, a silicon-based negative electrode (anode) was seen as a solution. However, charge capacity loss has actually accelerated with the use of silicon, as the material alloyed and de-alloyed during charge-discharge cycles.

Alternative Battery Technology: Carbon Nanotubes

Carbon nanotubes used in silicon anodes have been shown to eliminate the issues associated with alloying and de-alloying described above. Carbon nanotubes consist of cylindrical structures that resemble rolled-up sheets of hexagonal wire composed of bonds connecting carbon atoms. The structures themselves can be up to a millimeter long with nanometers in diameters. Recent tests have demonstrated that when such structures are grown on silicon surfaces via chemical vapor deposition (CVD), discharge capacity of 727 mA hours per gram was achieved (90-95% vs. non-carbon nanotube based batteries). The charge capacity improvement and the compact form of carbon nanotubes may hold the key to the next cycle in device miniaturization. ASM International is a vendor of CVD equipment and remains the only stock we cover that may benefit from a wider carbon nanotube use.

Exhibit 18: Carbon Nanotube



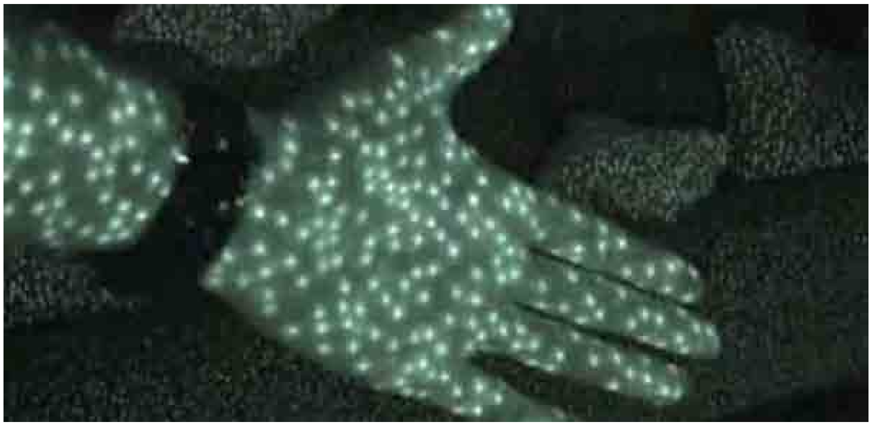
Source: TopNews.in.

User Interface: Gesture and Projection Technology

We believe that user manipulation of mobile data will evolve, with projected keyboards, voice, touch, and gesture all working together to enable content creation and manipulation.

We believe that for many mobile applications, gesture-based technology will be adopted. This technology is similar to that used by Microsoft (MSFT, $24.62, NC) in its Kinect gaming device, but miniaturized to allow the device to cover your movements with just a 4" screen. This laser and camera-based technology may be employed in conjunction with a pico projector (such as those offered by Microvision [MVIS, $0.96, NC]) to enable larger screen manipulation, as depicted in the exhibits below.

Exhibit 19: Motion Sensing Technology

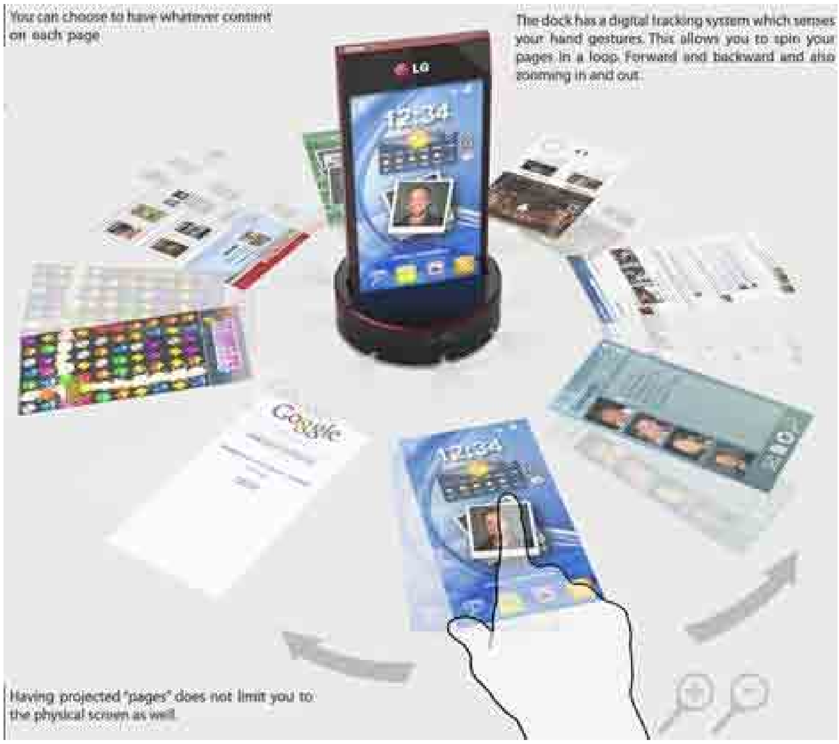


Source: gadgetmania.com.

Exhibit 20: Concept Pico Projector

Source: microvision.com.

Exhibit 21: Concept Multi-Page Pico Projectors



You can choose to have whatever content on each page

The dock has a digital tracking system which senses your hand gestures. This allows you to spin your pages in a loop. Forward and backward and also zooming in and out.

Having projected "pages" does not limit you to the physical screen as well.

Source: whatsthelatest.net.

Form Factors

In addition to typical mobile device form factors such as bar, clamshell, flip, slider and swivel, we believe there will be a variety of different form factors for consumers to choose from in the next decade, including watches, glasses, key chains and ear buds. Furthermore, the form factor of mobile phones will be miniaturized to allow them to be embedded into other devices or objects, such as a tablet, mobile TV, game console, camera, or media player. These devices will be interconnected with each other to the network. AAC Technologies (2018 HK, $13.98, Buy) is one of our favorite ways to play this trend.

The Possibilities of OLED

While 3D, transparent projected screens are likely beyond a 2020 timeframe, gesture-based input on any metallic, alloy or plastic surface is possible and probable, in our view. We think that the future of mobile displays is OLED (short for organic light-emitting diode) based. We believe OLED will allow high density pixilation on any metallic, alloy, or plastic surface, in almost any shape. We envision curved screens able to wrap around the wrist of users and large built-in wall screens that users can manipulate with gestures rather than keyboards or pointing devices (think of Tom Cruise in the movie "Minority Report"). Universal Display Corporation (PANL, $38.60, NC) is a leader developing emerging display technologies.

Exhibit 22: A Scene From the Movie "Minority Report" – Possible This Decade?

Source: Minority Report image, from tested.com.

Exhibit 23: Flexible OLED

Source: Universal Display Corporation.

Pictured above is a concept technology that is being developed by Universal Display Corporation. The flexible OLED will allow OLEDs to be "painted" on any type of flexible surface. We believe that by 2020, this type of technology will be readily available and will be used beyond traditional PC-type devices. Books, magazines, advertisements, and the print industry could be radically transformed as this technology would allow us to carry what amounts to a sheet of paper but provide access to a significant amount of dynamic, media-rich information.

Exhibit 24: OLED Watch Use-Case Concept

Source: Universal Display Corporation.

Exhibit 25: Military Applications for OLED

Source: Universal Display Corporation.

Pictured above is a wearable watch computer that is contoured for a soldier‘s wrist. This type of display would allow the soldier to carry a flexible, lightweight device into war and have access to a vast amount of battlefield data.

Eventually, OLED technology could become inexpensive enough to paint onto clothing such as backpacks or shirts. For example, a professional sports franchise could advertise on team jerseys equipped with discretely integrated displays.

Exhibit 26: Concept OLED Watch Application for Consumer Electronics

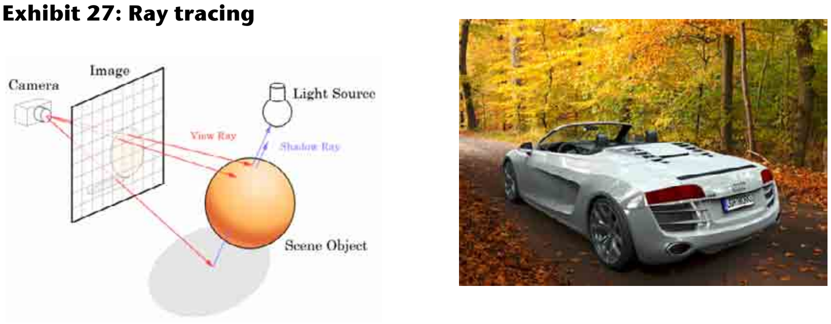
Source: concept-phones.com.

With the ability to affordably install ultra-slim, light-weight OLED displays on virtually any surface, we believe automobiles, trains, and airplanes could feature many more displays, potentially even mobile “sheets” that could be temporarily pasted onto a location. Appliances such as refrigerators, coffee makers, washers, and dryers could all easily integrate full color displays cost effectively and replace the pixelated monochrome displays that are popular on those appliances today.

Ray Tracing to Bring Graphics to Life

Ray tracing is a computer graphics technique capable of producing a very high degree of photorealism but at a greater computational cost than standard techniques of lighting. This often makes ray tracing best suited for images that can be rendered slowly ahead of time, such as still images or film, but more poorly suited for real-time applications like computer games where speed is critical. Ray tracing works by calculating the complete path of each light ray in a 3D scene, producing very accurate shadows and light tones. It also usually accounts for reflection and refraction and produces much softer, more natural results. Newer PC graphics chipsets, usually at the high end, can handle real time ray tracing while still preserving detail.

Exhibit 27: Ray tracing



Source: Company reports.

With the acquisition of Caustic earlier this year, Imagination Technologies (IMG LN) is banking on the future use of real-time ray tracing as de facto inside mobile GPUs (graphics processing units) within 5+ years. The company sees the potential for first deals being signed during FY12. IMG believes its real-time Ray tracing solution is "complementary" and will not over borrow cycles from its existing SGX cores when running. For now, however, we understand that adding Ray tracing *does* have an impact on power consumption in a SoC (system on a chip). However, solutions are unlikely to ship for another four years, with the inference that chip designers will fix this by then. Company management has noted that simplifying ray-tracing in game-playing can yield significant saving for developers, in a market where content generation can be expensive.

Security, Payments, and NFC

Later in this report, Jason Kupferberg addresses the important role that biometrics and NFC (near field communication) technologies will play in managing mobile security and payments. We mention these briefly here simply to highlight our expectation that these technologies will be increasingly integrated into mobile devices. NXP Semiconductors NV (NXPI, $15.94, Buy) and Inside Secure (private) are two vendors prominent in this field.

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Telecom Operator Perspective: Estimating Future Demand, Coping With It and Monetizing It

Executive Summary

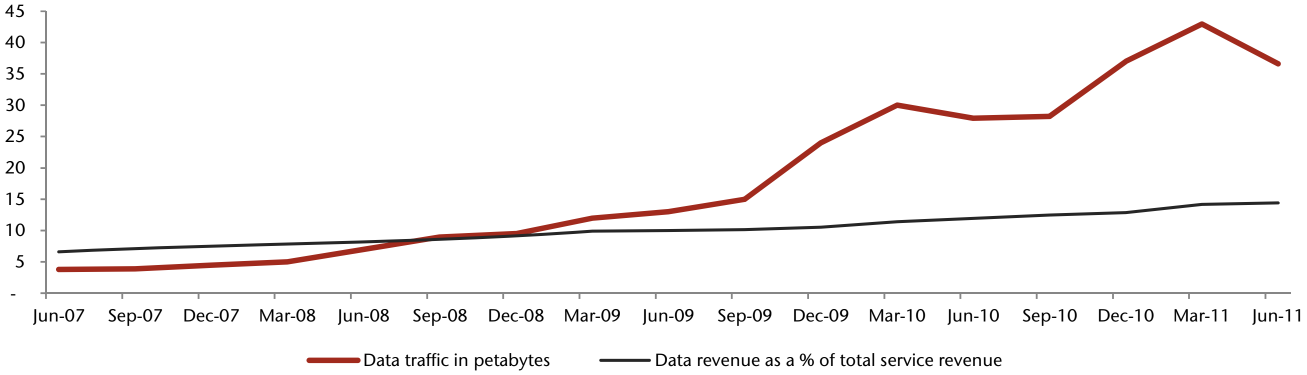
The Mobile Data Challenge. Telecom operators in developed markets are already fully committed to dimensioning their networks for coping with rapid growth in mobile data traffic. Ericsson (ERIC, $11.20, NC) reported in March 2010 that data traffic had already surpassed voice on its mobile networks globally. Accelerating take-up of smartphones, continuing adoption of mobile broadband “dongles,” and shifts in consumer usage behavior (strong appetite for streaming video and social networking sites in particular) are sustaining mobile data growth at very high levels. 3G deployments are also gathering pace in emerging markets. Herein, we examine the critical challenges that mobile data presents for the telecom service providers.

Estimating bandwidth requirements. We consider factors that will shape demand for bandwidth and how operators will organize themselves to meet it. The need to maintain acceptable investment returns will, of course, be paramount. Our analysis underlines the importance of maximizing spectrum, taking full advantage of traffic offload opportunities, and actively differentiating between types of traffic carried on the network.

Adapting service and revenue models. We examine how the telecom service industry’s share of wallet has evolved through previous growth opportunities (mobile, broadband), and we look at how effectively operators are monetizing mobile data so far. IP cannibalization has already emerged a very real side-effect of rising smartphone penetration in some countries. We discuss how operators can re-shape tariff structures to mitigate risk to legacy revenue streams. Can operators leverage their position in the mobile data value chain to create pricing power? We set out the relevant issues.

Key conclusions. Mobile data is unlikely to re-rate the telecom share of wallet, except in countries where fixed BB penetration is low. Voice/messaging will remain deflationary in developed markets. We are skeptical that escalating bandwidth demand will confer sustainable pricing power, other than for networks with a clear quality advantage. Cannibalization risk to legacy revenue should drive migration to integrated bundles. But a side effect of this will be more transparent pricing, something the industry historically sought to avoid. We see potential disruption to market structures with user behavior powerfully shaped by attraction to specific smartphones and operators likely to be rapidly appraised on the quality of the devices/connectivity they offer. Beneficiaries, in our view will be **Vodafone** (VOD LN, 161.00p, Buy) (in Europe, and VZW in the US) and **China Unicom** (762 HK, CNY16.28, Buy).

Exhibit 28: Vodafone Europe — Growth in Mobile Data Traffic Has Outpaced Growth in Mobile Data Revenues



Source: Company data; Jefferies & Co.
Note: Data traffic measured over 3-month period; data revenues exclude messaging.

Estimating Bandwidth Requirements

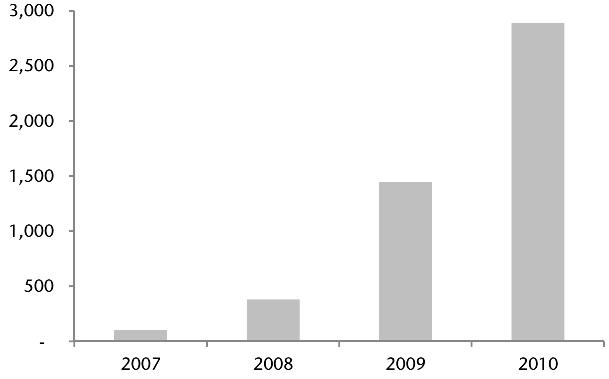
Historical perspective

Ericsson has reported a cumulative 28-fold increase in mobile data traffic globally between 2007 and 2010

Mobile networks are already experiencing an unprecedented surge in traffic volumes. In Western Europe, telecom regulators typically reported 11-13x increases in mobile data volumes in three years up to 2H 2010. Sweden reported a 23-fold increase. In the U.S., CTIA reports a 2.1-fold increase in 2H 2010 over 2H 2009. By our analysis, China Mobile (941 HK, HK$79.95, Hold) has experienced a 13x increase in mobile Internet access traffic between 2007 and 2010. Even in early-adopting Japan, where DoCoMo (9437 JP, ¥139,700, NC) launched i-mode back in 1999 and 3G FOMA in 2001, volumes continue to grow strongly: DoCoMo reported a 60% CAGR in data traffic in the three years to March 2011, despite maturing 3G penetration (now 98% of the DoCoMo base, only up 3 percentage points y/y) and the 4G Xi product not yet being material (26k subscribers as of March 2011). It is clear that individual consumption levels continue to climb.

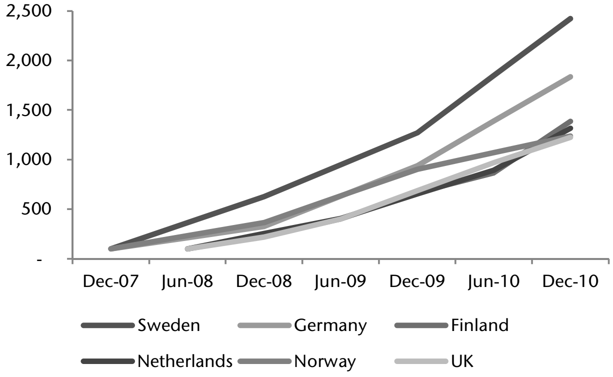
At a global level, Ericsson reported 280% annual growth in data traffic during 2008 and again in 2009, followed by a further doubling in 2010. It is against this backdrop of loosely controlled and (in many cases) poorly monetized acceleration in network traffic that operators are estimating their future bandwidth requirements.

Exhibit 29: Ericsson Global Mobile Data Traffic 2007-2010



Source: Ericsson; Jefferies & Co.
Note: Re-based to 100 units in 2007.

Exhibit 30: WEU Mobile Data Traffic 2007-2010



Source: FICORA, BNA, OPTA, NPT, PTS, Ofcom, Jefferies & Co.
Note: Re-based to 100 units at starting point.

Future traffic growth will be shaped by the economics of supplying it

Traffic growth will be determined by supply as well as demand

It is notoriously difficult to estimate future growth rates of a new product experiencing exponential adoption. In the case of mobile data, when measured by volume, it can be argued that virtually any amount of bandwidth can be absorbed by consumers in principle. We believe the limits of demand are less set by intrinsic saturation, but by the price point, which is determined by competition and the economics of the product.

Applications are ultimately tailored according to available bandwidth – e.g., video streaming formats are tailored around prevalent data rates rather than the other way around, and it is not difficult to envisage exponential growth of data volumes from video and audio streaming applications in particular. A cautionary note on any specific forecast of bandwidth demand is provided by the estimates in the early days of fixed broadband that have proven highly inaccurate.

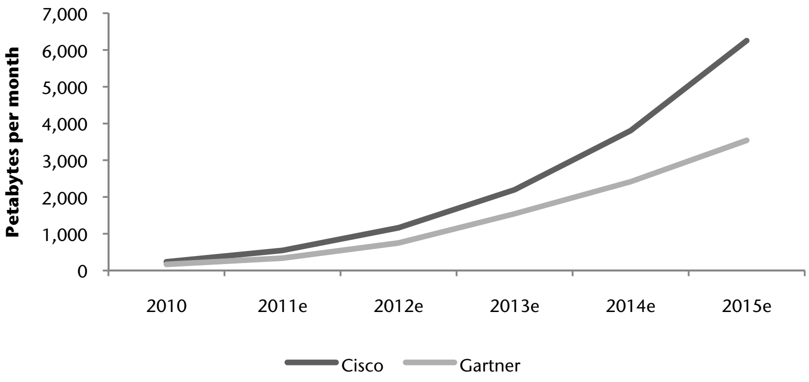
Operators themselves face the commercial imperative of bringing new data products

What is assured, in our view, is that traffic on mobile networks will continue to grow very strongly. But consumer appetite will not be the only driving force. Operators themselves face the commercial imperative of bringing new data products on stream to replace the commoditized voice/SMS products that current make up most of the revenue base. Any operator that falls behind its rivals in bringing new bandwidth on stream would be threatened by increased customer churn.

Nevertheless it is basic economic theory that will determine the amount by which bandwidth consumption grows over the long-run. Demand will be a function of the price that consumers are prepared to pay, while supply will depend on the amount of bandwidth that operators are available to deliver consistent with preserving an economic return. Where the two curves meet will dictate how much bandwidth is required.

A number of well-informed organizations have attempted to forecast global mobile data traffic growth over the next few years. In the chart below, we show projections from Cisco and Gartner, noting the fairly wide variance between them. Rather than present yet another set of estimates ourselves, our approach is to analyze whether the Cisco/Gartner projections are likely to be economically supportable from an operator perspective.

Exhibit 31: Global Mobile Data Traffic Forecasts 2011-2015



Source: IMF (WEO database); Cisco Visual Networking Index, June 2011; Gartner Forecast Mobile Data Traffic and Revenue, worldwide 2010-2015; Jefferies & Co.

Exhibit 32: Mobile Data Traffic Forecasts 2011-2015

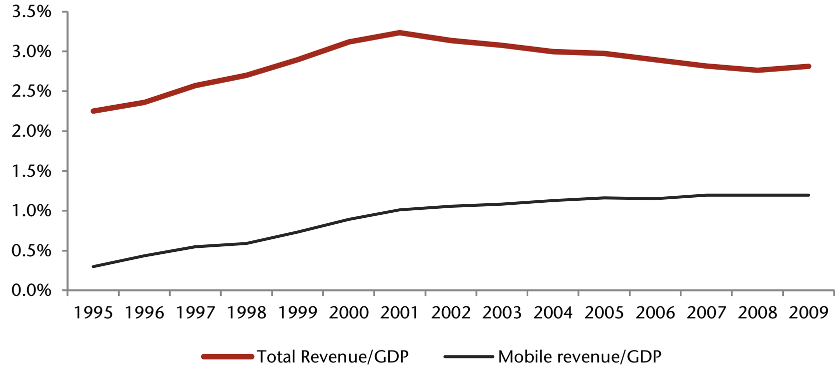
Data (TB per mth)	**2010**	**2011e**	**2012e**	**2013e**	**2014e**	**2015e**	**CAGR '10-15e**
ASPAC	54,919	128,445	269,218	529,806	996,624	1,836,842	102%
CEE	10,312	24,617	55,733	110,011	200,927	346,296	102%
Japan	40,245	86,478	172,112	289,322	425,161	577,998	70%
LATAM	11,687	25,997	60,486	127,206	257,463	487,784	111%
ME & NA	6,147	16,744	44,473	90,324	178,570	387,078	129%
North America	48,959	118,084	235,411	416,025	674,579	986,039	82%
Western Europe	64,407	145,685	325,518	634,869	1,072,665	1,631,953	91%
Global	**236,676**	**546,050**	**1,162,951**	**2,197,563**	**3,805,989**	**6,253,990**	**92%**

Source: IMF (WEO database); Cisco Visual Networking Index, June 2011; Jefferies & Co.

Telecom's share of wallet

Total telecom revenue has been relatively stable as a percentage of GDP in OECD countries since the TMT bubble burst in 2000 (see chart below), following an expansion from 2.25% to 3.12% between 1995 and 2000. While mobile and broadband emerged as revolutionary new products for the industry during the 1990s, the period since 2000 has encompassed much of their development towards mass-market maturity. Globally, mobile service revenues as a percentage of GDP increased by just 6bp between 2007 and 2010 (as illustrated further in the table below).

Exhibit 33: Total Telco Revenue and Mobile Revenue as a % of GDP



Source: OECD; Jefferies & Co.

Data yields in 2015

In this section we set out a framework for estimating how mobile data will be priced in 2015, based on an assumption about how mobile spend as a percentage of GDP will evolve between now and then. We start by examining how mobile spend as a percentage of GDP has trended in the last five years across seven broad geographic regions (table below). We find strong increases in Latin America, Middle East & Africa and in North America, but material declines in Europe.

Exhibit 34: Mobile service revenues % GDP

	2005	2006	2007	2008	2009	2010	Delta 2005-10
APAC	1.55%	1.61%	1.62%	1.63%	1.65%	1.57%	0.02%
CEE	1.56%	1.54%	1.49%	1.55%	1.63%	1.40%	-0.16%
Japan	1.39%	1.40%	1.36%	1.35%	1.41%	1.38%	-0.01%
LATAM	1.31%	1.46%	1.71%	1.78%	1.83%	1.92%	0.61%
ME & Africa	2.14%	2.20%	2.54%	2.47%	2.90%	2.70%	0.56%
North America	0.95%	1.01%	1.07%	1.10%	1.16%	1.18%	0.23%
Western Europe	1.27%	1.25%	1.23%	1.21%	1.22%	1.17%	-0.10%
Global	**1.28%**	**1.32%**	**1.38%**	**1.40%**	**1.46%**	**1.44%**	**0.15%**

Source: Gartner; IMF; Jefferies & Co.

Taking the historical trend into account, we forecast mobile spend as a percentage of GDP in 2015 for each of the regions. We assume moderating growth in regions where spending levels have been on the increase (justified by maturing mobile penetration levels, in our view) and greater resilience in Europe (implied revenue growth to 2015 is consistent with the aggregate of our forecasts for the companies we have under coverage). We take GDP forecasts published by the IMF in April 2011 and apply our own prudent scaling down factor across all regions. This enables us to forecast mobile revenues in 2015 regionally.

We use the Cisco data traffic forecasts that we referred to earlier in this section. Globally, Cisco forecasts a 25x increase in mobile data traffic between 2010 and 2015, with regional increases ranging from 19x in Japan to 62x in Middle East & Africa.

Attributing forecast revenues in 2015 entirely to mobile data (with no allocation to voice/messaging for simplicity's sake), we find that the effective level of pricing implied by this analysis amounts to about $0.016 per MB ($0.011-$0.028 by region).

Exhibit 35: Implied Mobile Data Yield in 2015E

	Mobile revs	Mobile revs	Nominal GDP	Mobile revs	Data traffic	Data yield	Data yield
	% GDP, 2010	**% GDP, 2015e**	**(US$bn), 2015e**	**(US$bn), 2015e**	**(TB per month)**	**(US$ cent/MB)**	**(€$ cent/MB)**
APAC	1.57%	1.60%	18,296	293	1,836,842	1.3	0.9
CEE	1.40%	1.50%	5,790	87	346,296	2.1	1.5
Japan	1.38%	1.40%	5,742	80	577,998	1.2	0.8
LATAM	1.92%	2.20%	6,281	138	487,784	2.4	1.7
ME & Africa	2.70%	2.50%	5,149	129	387,078	2.8	1.9
North America	1.18%	1.30%	17,994	234	986,039	2.0	1.4
Western Europe	1.17%	1.17%	17,579	206	1,631,953	1.1	0.7
Global	**1.44%**	**1.52%**	**76,830**	**1,166**	**6,253,990**	**1.6**	**1.1**

Source: Gartner; IMF; Cisco; Jefferies & Co.

Looking at Western Europe in more detail, we estimate a 2015 data yield of €0.007/MB. This is not far from current yields for data traffic (estimated €0.01/MB) and we would be closer to that level if we applied less aggressive Gartner traffic growth assumptions seen in the chart above, or assumed a more optimistic uptick in spend as a percentage of GDP.

However, currently slightly less than half the mobile traffic is on voice with a retail yield typically 100x above the retail yield on data. In aggregate, the average yield per unit of capacity would decline by a factor of fifty if we take Cisco's volume and the IMF's GDP forecasts at face value but do not assume that spending on mobile services increases as a share of GDP. (If we were to include voice forecasts separately, this multiple might change, but not by an order of magnitude.)

Capital efficiency

Revenues ultimately determine the budget available for capital spending. With our big-picture analysis implying such a substantial decline in revenue per unit of bandwidth delivered, it is clear that transforming capital efficiency has to be a central focus.

This sets a steep challenge to the equipment vendors, both in terms of pricing and in helping operators to use existing spectrum allocations more efficiently, for example by deploying LTE and re-farming frequencies currently used only for 2G.

Operators will need to maximise any economically sensible opportunities to limit congestion on their networks.

- **WiFi offload –** WiFi is becoming standard on smartphones globally. Software applications that enable seamless switching between 3G and WiFi networks, depending on which offers better signal strength, are increasingly being deployed by operators (e.g., by AT&T [T, $28.48, NC] on iPhones since 2009 and KDDI in Japan on all smartphones since June of this year). In the U.S., AT&T is the clear leader on this network strategy with over 27,000 WiFi hotspots including the development of entire 'hot zones' in congested outdoor urban areas like New York's Times Square. Verizon (VZ, $35.88, NC), which had de-emphasized an earlier WiFi effort, announced in May that it would give 3G and LTE data subscribers free access to WiFi hotspots in select locations. Vodafone disclosed last May that it is offloading about 10% of its European 3G data traffic via WiFi. Offloading can come in the form of consumers accessing their home broadband connection via a WiFi router, access to wide area WiFi networks provided by a mobile operator (e.g., Vodafone, Orange and O2 bundling access to BT's Openzone WiFi network into mobile data plans) or third-party WiFi providers (such as BT, The Cloud, or retailers directly). Some municipal WiFi deployments have suffered from poor service quality owing to backhaul being shared among multiple hotspots. This causes users to experience poor latency, an important issue for some real-time applications such as VOIP (voice over IP). KDDI has an explicit "multi-network" strategy which includes a nationwide WiFi network targeted to reach 100,000 hotspots by March 2012. SK Telecom (SKM, 16.08, NC) is growing its WiFi network from 17,000 hotspots at the end of 2010 to 62,000 by the end of this year. South Korean operators have also augmented their mobile data offerings with WiBro, a mobile WiMAX service. Same in China: the largest Chinese wireless operator China Mobile indicated that it plans to have one million hotspots by the end of 2013 to alleviate the pressure from data traffic growth. China Unicom and China Telecom are also using WiFi offload to complement their HSPA and CDMA EVDO networks, respectively.

- **Femtocell offload –** We are cautious on the potential for femtocell offload to help relieve network congestion. Despite significant marketing efforts, operators have had limited success selling femtocells into the consumer segment. Consumers have proved unwilling to be charged for the device. Subsidising it in full makes little economic sense for all but high-spending users in markets where consumers typically churn between networks every few years. Another drawback is that operators lose control over service levels, since these are influenced by factors such as the quality of the customer's residential fixed broadband connection. However, various operators including China Mobile are currently offering femtocell offload to corporate customers.

- **Spectrum acquisition/re-farming –** In 2010, Vodafone reported that 35% of traffic originated on 10% of its cell sites. Relieving congestion by cell splitting can be expensive and may also be difficult in practical terms if new sites are scarce. Deploying a new carrier at an existing site will drive additional capex (new transceivers, backhaul) and opex (power, maintenance, backhaul if leased lines are used). For a typical WEU operator, we estimate the incremental cost of delivering 1Gbyte of capacity at €0.6 through a new carrier, compared to €2.6 where capacity is created by cell splitting. We have estimated incremental throughput on the new carrier based on realistic performance under normal conditions on today's HSPA (high speed packet access) networks (not the "ideal" peak rates often quoted) and taking into account the network efficiencies (so-called "trunking gains") that result from creating a larger pool of spectrum by deploying a second contiguous block. If spectrum has to be acquired to secure the new carrier, auction costs also need to be taken into account. The average cost of 800MHz/2.6GHz frequencies sold in Europe over the last three years has been €0.6/€0.03 per MHz per capita. In this context, we mention that a strong case could be made that the primary rationale for AT&T's purchase of T-Mobile USA was to materially increase the spectrum portfolio and cell site density. AT&T management has indicated that no other alternative gave them more capacity sooner, and that the resultant cell splits are expected to double 3G capacity in many areas. Operators in some regions are also actively "re-farming" spectrum currently used for GSM voice/basic data services where throughput is low (typically 10-20kbps in each 0.2MHz channel) to 3G. This allows them to take advantage of order-of-magnitude gains in spectral efficiency, to use the spectrum where it is most needed (providing high-speed data services) and to bring more low-frequency spectrum with better long-distance and in-building propagation characteristics into their 3G deployments. The GSA (Global Mobile Suppliers Association) reports that UMTS (3G) services have been deployed in the 900MHz band by 34 operators in 25 countries, as of July 2011.

Exhibit 36: Incremental Cost of adding capacity (EUR/GBYTE)

	New carrier	Upgrade site	New site
Capex (EUR k)	15.0	60.0	90.0
Depreciation rate	10%	10%	10%
Capex pa	1.5	6.0	9.0
Incremental opex pa	8.0	15.0	23.0
Total annual cost	**9.5**	**21.0**	**32.0**
Number of sectors	3	3	3
Annual cost per sector (EUR k)	**3.2**	**7.0**	**10.7**
Average throughput (Mbps)	**3.0**	**3.0**	**3.0**
Maximum cell loading	70%	70%	70%
	2.10	2.10	2.10
Trunking gain from additional carrier	30%	0%	0%
Effective throughout (Mbps)	**2.73**	**2.10**	**2.10**
Seconds in one hour	3,600	3,600	3,600
Hours per day when demand is significant	12	12	12
Days per year	365	365	365
Effective throughout (Mbit pa)	43,046,640	33,112,800	33,112,800
8 bits = 1 byte	8	8	8
Mbytes to Gbytes	1,024	1,024	1,024
Effective throughout (Gbyte pa)	**5,255**	**4,042**	**4,042**
Incremental cost per Gbyte (EUR)	**0.6**	**1.7**	**2.6**

Source: Jefferies & Co. estimates. Underlying cost and throughput estimates from Neu Mobile consultancy.

- **Network sharing –** Passive sharing has been commonplace in Europe for the last ten years. In India, severe price erosion and the need to deploy rapidly in growing rural circles have forced operators to embrace tower-sharing as a core part of their business models. Vodafone reported in March 2011 that more than 40% of its base stations are now shared. Active sharing, however, is more complicated and therefore less widely adopted. The failure of RAN (radio access network) sharing ventures such as Vodafone-Orange in the UK and Hutchison-Telstra in Australia have illustrated practical difficulties around balancing conflicting coverage/service quality objectives and determining how economic benefits/costs should be shared. In the UK, Orange, T-Mobile and 3UK have already merged infrastructure assets into a joint venture, although this has yet to result in any discernable competitive or cost advantage. In the US, Sprint (S, $3.76, NC) became the first major wireless operator to embrace network sharing when it announced in December 2010 that it planned to install multi-mode base stations capable of handling the company's current spectrum portfolio as well as other spectrum bands. In July 2011, Sprint entered into a "Spectrum Hosting and Network Services Agreement," with LightSquared whereby LightSquared will pay Sprint to deploy and operate a nationwide LTE network that hosts L-Band spectrum licensed to or available to LightSquared. We would argue this is a special case and believe that many operators – particularly those with scale economies and strong spectrum allocations – will be keen to drive potential network advantages in the longer term and so should be reluctant to go beyond passive sharing. We believe that network sharing beyond site sharing will remain limited unless market economics really compel operators to cooperate (as in Sweden or India).

Exhibit 37: Chinese Telco Base Stations and Spectrum Summary

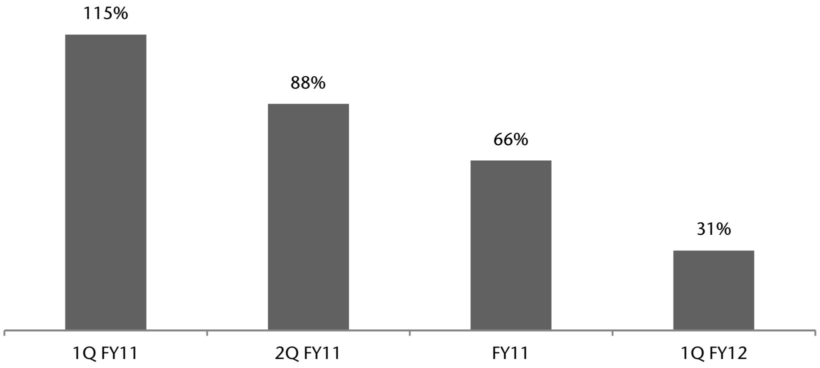
Wireless Telecom Network Assets	Wireless Sprectrum	No. of Base Stations
China Mobile GSM/TD-SCDMA	Total 40MHz of spectrum in the 900MHz and 1800 MHz frequency band. 3G: 1880-1900 MHz	Total GSM and TD base stations are approximately 800K. (1H11) 2G: 554K (2010) 3G: 199K (1H11)
China Unicom GSM/WCDMA	15x2 MHZ of spectrum in the 900 MHz frequency band, and 20x2 MHz in the 1800 MHz frequency band. 3G: 2x15 MHz in the 1900 MHz frequncy band	Total GSM and WCDMA base stations are 551K. (1H11) 2G: 348K (1H11) 3G: 203K (1H11)
China Telecom CDMA/EVDO	10x2 MHz of spectrum in the 800 MHz frequency band; is getting approval fro 4MHz more spectrum from the government in 800MHz band. 3G: 1920-1935 MHz, 2110-2125 MHz	Total number of CDMA/EVDO base stations are 210K. (1H11) 2G: 50K (1H11) 3G: 160K (1H11)

Source: Company data; Jefferies & Co.

- **LTE –** Globally there were 24 commercial networks in 16 countries as of early July per the GSA. LTE can be deployed in existing 2G or 3G bands, or in newly allocated spectrum. It offers improved spectral efficiency over existing 3G/3.5G deployments, faster data-rates, more symmetry between downlink and uplink, and lower latency. Verizon has indicated that through a combination the global nature of the LTE ecosystem, upgrading backhaul facilities and the inherently more efficient nature of the LTE technology it expects to eventually lower the cost of delivering a MB to one-fifth of the current cost/MB on EVDO. DoCoMo has highlighted the role of LTE in its network planning to cope with growing packet traffic. In Scandinavia, operators are seeking to leverage a price premium from the faster data-rates: high-end 80Mbps 4G packages are being priced at a 120-130% premium to high-end 16Mbps 3G plans. In Germany, license conditions have required LTE to be initially deployed in the rural "white spots" and so operators are positioning the product initially as an alternative for poor quality (or unavailable) fixed broadband.

- **Throttling demand** — Another data-point provided by Vodafone last May was that "optimising" Web/video traffic on seven of its networks led to 15-30% volume reductions last year. Throttling demand can take the form of identifying the most data-intensive consumers and adjusting their tariffs or cutting quality of service. Consumers either regulate their behavior or churn off. The re-introduction in the U.S. of usage-based pricing for heavy users after years of essentially unlimited plans is an obvious example of this form of traffic management. AT&T was the first to return to this form of pricing in response to the unprecedented mobile data growth volumes experienced as a result of the introduction of the iPhone, and Verizon has recently followed suit. In addition to this, however, operators are also widely deploying deep packet inspection to tailor quality of service levels to the perceived economics of each type of traffic.

Exhibit 38: Vodafone Europe — Data Traffic Growth (y/y)



Source: Company data.
Note: Data traffic growth is not reported after every quarter.

Another factor that might temper traffic growth on mobile networks, independent of any operator initiatives is "storage," the ability of advanced devices to store content rather than download it over the air. Current high-end smartphones have flash memories towards 32GB, and often support add-on flash memory. Such memory stores significant amounts of content (e.g., video the typical smartphone screen size is often found encoded at around 0.4-0.5GB/h, although the rates vary widely depending on video quality). Clearly, this means the subscriber can download content either via the home Internet connection, or in areas of WiFi coverage (hotel room, coffee shop) for consumption at a later time. Bandwidth demand forecasts such as those from

Cisco/Gartner presented above are specifically for mobile data transmitted through the chargeable mobile RAN, not including WiFi offload. Over the long-run we see “storage risk” to operator business models outweighing any short-term traffic management benefits. Operators may find themselves heavily subsidising expensive devices, which will likely result in chargeable traffic in cases where customers need to access a real-time application and are outside the range of an alternative connection.

Adapting Service and Revenue Models

Monetizing mobile data – the story so far

In the previous section we showed how total telecom spend as a percentage of GDP has been broadly flat across OECD markets since 2000, and how mobile telecom spend as a percentage of GDP also appears to have leveled out in recent years, particularly once short-term recessionary influences are taken into account.

However, operators from around the world are reporting material growth in mobile data revenue. Even if revenue growth rates are increasingly decoupled from the even greater levels of underlying traffic growth, this still conveys the impression of operators doing a solid job of monetising the new structural growth opportunity.

- **Japan/Korea –** In Japan, we estimate that data accounted for 50% of wireless service revenue for the three main operators in the year to March 2011. Despite the relative maturity of 3G (98% of DoCoMo subscriber base in March 2011), Japanese operators still delivered aggregate data revenue growth of 10% last year (vs. 8% in FY10 and 13% in FY09). In Korea, SK Telecom reported 13% growth in wireless Internet revenues in the year to December 2010 (vs. 9% in 2009), and data now accounts for 27% of wireless revenue (vs. 24% in 2009).
- **China –** The 3G market is still relatively undeveloped, accounting for 9.5% of the wireless subs (but two-third of net adds). However, mobile data already accounted for 32.2% of revenue at China Mobile in 1H11 (vs. 25.7% in 2007) and for 21.9% when maturing SMS is excluded (vs. 13.9%). We calculate that non-SMS data revenue growth at China Mobile grew 29% in each of the last two years. Despite low penetration of 3G handsets, China Mobile has successfully monetized a range of other data products including wireless music, MMS, the Mobile Market store and mobile broadband "dongles." The need to contain an estimated 13-fold increase in mobile Internet traffic since 2007 is prompting management to focus on handset-based applications. Differing technology platforms and upgrade paths among the Chinese operators create a divergence in value chains that we do not observe in many other markets. We expect the proliferation of 3G smartphones becoming available to China Unicom and China Telecom to enable both operators to grow market share. Currently, data revenue contributes 42.2% of total service revenue for China Telecom compared to 25.8% in 2007. For China Unicom, data revenue accounted for 35.3% service revenue in 1H11, compared to 21.6% in 2007; excluding SMS, data revenue accounted for 26.6% service revenue compared to 12.1% in 2007.

Exhibit 39: Chinese Telco Data Revenue Contribution and Traffic Growth

Data rev as a % of service revenue				
		1H10	**1H11**	**YoY**
China Mobile		29.5%	32.2%	2.6%
China Telecom		38.1%	42.2%	4.1%
China Unicom		27.7%	35.3%	7.6%
Wireless data Traffic Growth				
Bn MB		**1H10**	**1H11**	**YoY**
China Mobile	2G+3G	53.5	137.1	156.2%
China Telecom	3G	5.2	9.4	78.3%
China Unicom	2G	2.1	7.3	256.2%
	3G	4.2	29.8	602.2%

Source: Company data; Jefferies & Co.

Exhibit 40: Chinese Telco Average Data Usage per Month per User

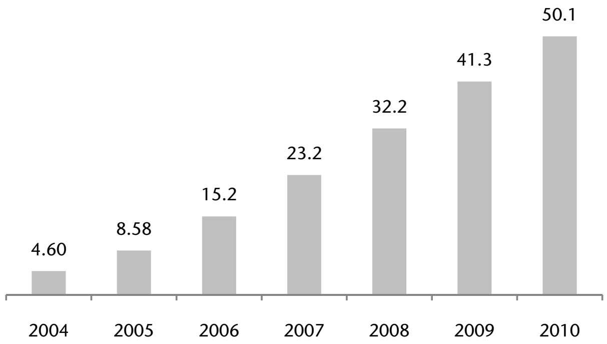
China Mobile	
Handset user	20MB
Smartphone user	40MB
iPhone user	60MB
China Telecom	
Smartphone user	100MB
Data card user	1G
China Unicom	
Smartphone user	107MB (up from 46MB in 1H10)
iPhone user	400MB (approximately)
Data card user	1.6G

Source: Company data; Jefferies & Co.

- **US** – The CTIA reports that non-voice (including text) reached 31% of US wireless revenues in 2010, up from 7% in 2005. In absolute terms, non-voice revenue have been increasing at a steady pace for the last four years (+$8.0-9.1 billion per annum) driven by increasing penetration of bolt-on data plans. Non-voice revenue growth of 21% in 2010 compares against data volume growth (also reported by the CTIA) of 110%.

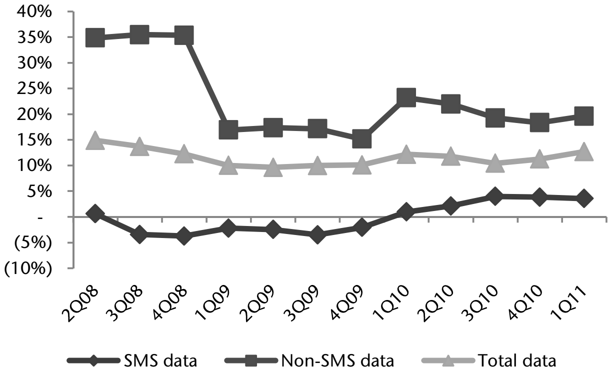
- **Europe** – Aggregating across the top six WEU markets (where mobile data disclosure is consistently provided by most operators), we see data revenue including SMS growing at a stable +10-13% y/y over the last two years. Within the mix, non-SMS revenues have been growing a steady ~20% per year driven by rising smartphone penetration (Vodafone Europe: 19% March 2011, up from 12% in March 2010) and data-attach rates (48% from 42%).

Exhibit 41: US Mobile Non-Voice Revenue ($ in billions)



Source: Company data; Jefferies & Co.

Exhibit 42: WEU Data Revenue Growth Rates (y/y change)



Source: Company data; Jefferies & Co.

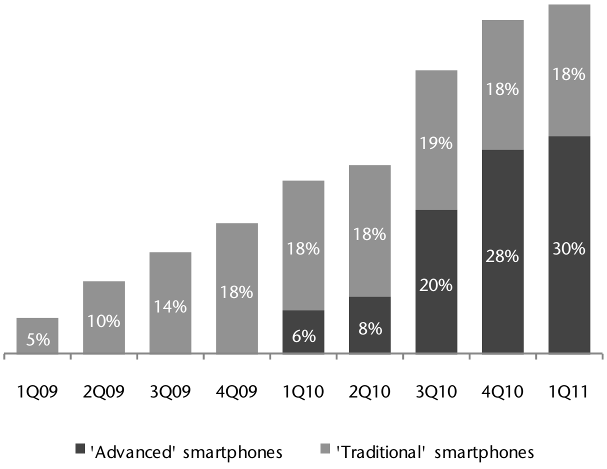
Flatter trends at the overall revenue level clearly reflect the commoditization of legacy voice revenue streams, augmented in Europe by regulatory pressure on interconnection and roaming rates. A secular shift to increase the proportion of retail revenue being included within bundles also makes the allocation of revenue to “data” an increasingly judgmental exercise.

Cannibalisation risk

The sharp discount at which mobile data is sold relative to mobile voice (€0.01/MB vs. €1/MB) is creating arbitrage opportunities. If customers can use their mobile data allowance for voice, they may be able to save a lot of money. Mobile VOIP threatens an outgoing voice revenue stream which accounts for about 60% of operator revenues today. Other smartphone applications threaten SMS, currently roughly 10% of operator revenue. The impact is already being felt:

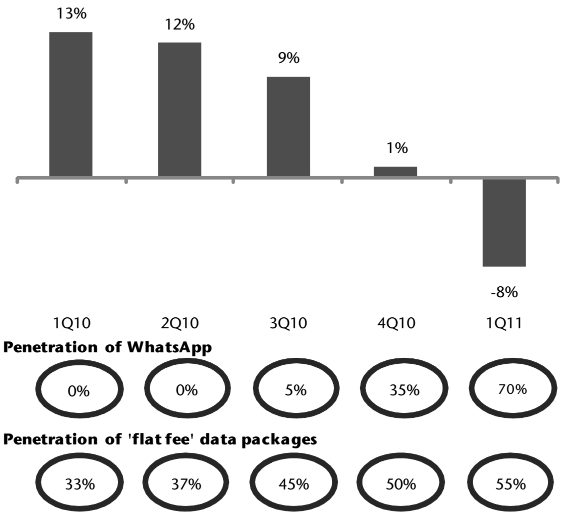
- **KPN (KPN NA, €9.97, NC) –** In 1Q11, KPN issued a profit warning which it attributed largely to cannibalization of legacy voice and SMS revenues by the mobile data channel. In particular, management highlighted rapid adoption of the WhatsApp application by smartphone users at its youth Hi brand. As WhatsApp penetration in this segment surged to 70% (from just 5% in 3Q10), growth in outgoing SMS/sub plunged to -8% y/y (from +9%).
- **O2 UK –** O2 has built a no.1 position in UK mobile over the last 10 years by consistently focusing on innovation, bringing new products to market first. Its customer base reflects these core principles. Normally a very consistent performer, O2 has reported sudden drops in service revenue growth over the last two quarters. The slowdown has been much greater than that reported by UK rivals affected by common headwinds (mobile termination rate, or MTR, reductions, macro backdrop). SMS revenue trends have been particularly severe: -1.4%/+1.2% y/y in 2Q/1Q11 (from +6.0% 4Q10 and +6.5% 3Q10).

Exhibit 43: "Advanced" Smartphone Penetration Among Contract Base at KPN's "Hi" Youth Brand



Source: Company data.

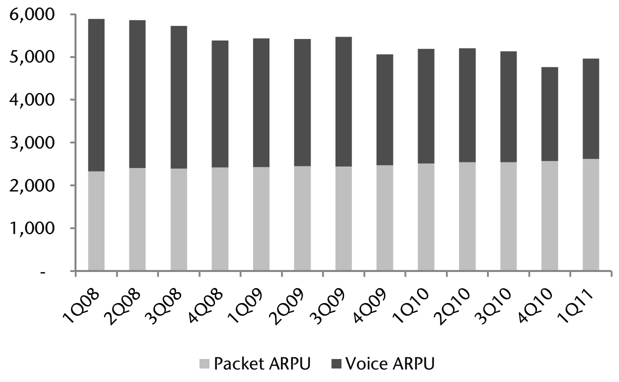
Exhibit 44: Growth in Outgoing SMS/sub at KPN's "Hi" Brand



Source: Company data.

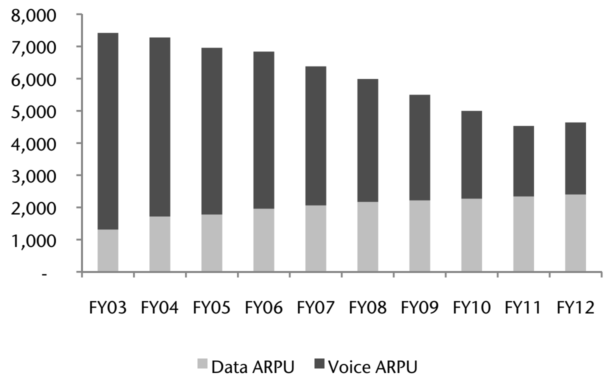
- **DoCoMo/KDDI –** Japanese operators have experienced rather steady erosion in wireless service revenue, beginning around 2003 and spanning the period of mass-market 3G adoption. DoCoMo, for example, has seen wireless service revenue decline at -2.5% CAGR over the last seven years, although this appears to be stabilising (-0.8%/-1.6% in the last 2 years). While there has been no shock cannibalization event in Japan, the initial adoption phase for mobile data was characterised by fairly sharp declines in voice MOUs as consumers substituted messaging for calls. Gradual decline in voice MOUs continues to the present day. A more technical factor that has depressed revenue trends is the decision of Japanese operators to de-emphasize handset subsidies in favor of discounting monthly fees. The charts below illustrate the recent ARPU declines at DoCoMo and KDDI. DoCoMo is guiding to ARPU inflection this year as rising packet (data) ARPU outstrips falling voice spend. It is worth noting, however, that smartphones are still at a relatively nascent stage in Japan: DoCoMO sold only 2.52 million in the year to March 2011 and is targeting an installed smartphone base of 6.0 million (10% of subscriber base) by March 2012. Devices sold in Japan historically have generally been tailored by operators to access a well-controlled ecosystem of applications built on platforms such as i-mode. As adoption of smartphones, with open operating systems, gathers scale, operators may find that controlling consumer behavior and monetizing applications becomes more challenging, in our view. The straightforward model of cross-selling data plans into customers as they adopt smartphones (which has been so effective in the U.S., for example) is made complicated in Japan by already-high subscription rates on flat-rate data plans (70% of DoCoMo base).

Exhibit 45: NTT Docomo – Voice and Packet ARPU (¥)



Source: Company data; Jefferies & Co.

Exhibit 46: KDDI – Voice and Packet ARPU (¥)



Source: Company data; Jefferies & Co.

New tariff structures and defensive tactics

To mitigate cannibalization risks, operators are adopting a variety of commercial and technical measures:

Operators are fighting mobile VOIP

- **Commercial measures** could include the contractual prohibition of mobile VOIP or incremental charges for VOIP usage. Operators can also bundle voice minutes and SMS buckets with mobile data allowances in integrated packages that implicitly undermine the arbitrage opportunity.
- **Technical measures** such as preventing VOIP capability on mobile devices sold through the operator or inspecting usage on the network and blocking VOIP traffic are fairly commonplace. Less confrontational to regulators and consumer groups (but equally effective) could be to degrade the quality of VOIP traffic by increasing jitter and latency.

Migration to integrated plans should support data revenue but may not stimulate higher retail spend overall

Vodafone reported post-1Q that over 25% of Europe consumer contract revenue is already derived from integrated voice/SMS/data plans. This includes a much higher proportion (about 50%) in the Netherlands and the UK.

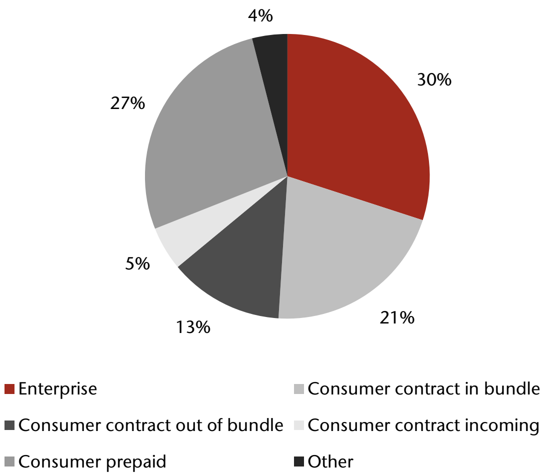
Integrated data plans are logically structured to raise pricing on the mobile data element to restrict potential for cannibalization of legacy revenue streams. If the rate at which customers are migrated to integrated tariffs were to accelerate, reported data revenue growth could increase even if growth in data traffic carried on the network were to slow. Clearly the flipside of accelerating data revenue growth delivered in this way is more downward pressure on voice/SMS (aspects of the revenue mix logically priced lower within integrated bundles).

So while the accounting implications of integrated plans should naturally support reported data revenue growth rates, the key objective for operators is to stimulate higher retail spending in overall terms (voice+SMS+data). Two factors may shape how successfully this is achieved:

- The degree of price elasticity accompanying the shift to all-inclusive bundles will be heavily influenced by the current level of retail spending in each market. Where spend/POP is highest, we suspect that operators may find customer response quite inelastic.
- The shift to (simpler) integrated bundles adds more transparency to mobile pricing, and this could encourage tariff optimisation. As falling MTRs enable smaller operators to price the outgoing voice buckets more competitively, it seems possible the price points attached to integrated bundles could fall. In an environment where mobile revenue continues to decline at a market level, smaller operators retain a strong incentive to grow market share and avoid negative operating leverage associated with revenue decline.

Vodafone presented a chart in July (replicated below) which argued that only 18% of its European mobile revenue (13% consumer contract out-of-bundle and 5% consumer contract incoming) was exposed to substitution risk from IP based messaging. However, the more traditional pressures we have cited could see consumer contract in-bundle revenues also coming under pressure in due course.

Exhibit 47: Vodafone Europe - Mobile Service Revenue Mix, 1Q12



Source: Company data.

Tiered data plans yet to reinforce revenue growth as promised

AT&T's shift to tiered data pricing in June 2010 was quickly copied in Europe, particularly in the UK where it has been the market norm for the last two or three quarters. Tiered plans were intended to accelerate data revenue growth. UK experience, however, is that most customers are still well below the monthly usage level at which an operator sends an alert and offers to sell them an additional data bundle. The most specific disclosure on this comes from O2 UK, which reported last April that 50% of its consumer contract subs had been migrated to tiered data plans but that only 3% of these reached 80% of their monthly 500Mbyte usage allowance each month, and only one-quarter of that subset then went on to purchase an additional data allowance.

The principal benefit so far from tiered data plans has been freeing up network capacity (managing heavy users >3GB/month has released 7% additional capacity for O2) rather than revenue accretion. Going forward, operators should be able to increase the proportion of customers buying bolt-ons as usage levels rise and as new tariffs segment data allowances more finely (lowest allowance is now 100MB/month).

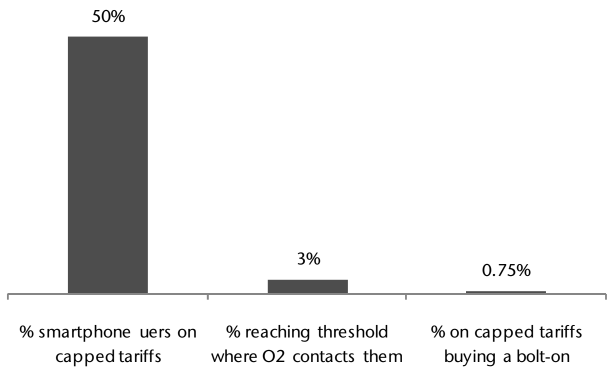
Do smartphones actually boost 'Customer Lifetime Value'?

Operators typically argue that the arrival of tiered data plans, lower device costs and lower marginal network costs would boost the uplift in CLV (customer lifetime value) achieved when a specific customer is upgraded to a smartphone. Few managements attempt to quantify the uplift, however. When O2 UK did provide some disclosure last April, it was striking how modest the numbers involved were. In 2010, before the widespread adoption of tiered data plans, O2 UK was achieving a CLV uplift of just 10p migrating a customer to a smartphone.

Strategies in flux, even in the advanced Swedish market

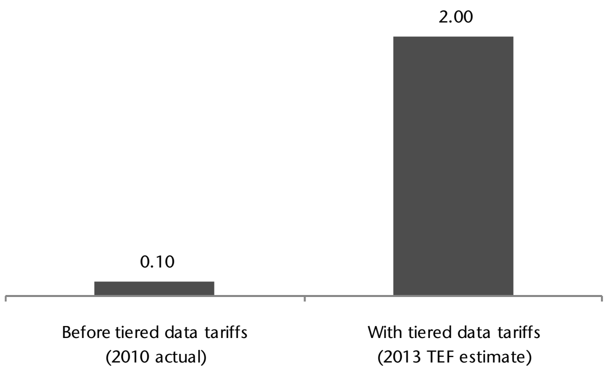
At the post 1Q11 analyst meeting, TeliaSonera (TLSN SS, SEK45.33, Underperform) suggested that its current focus is on driving smartphones into the mass-market base and ensuring that it does not lose market share to rivals during this rapid take-up. Even in the advanced Swedish market, however, TeliaSonera accepts that strategies for monetizing heavy smartphone investments are still in flux.

Exhibit 48: O2 UK - Customers Captured on Tiered Data Tariffs



Source: Company data.

Exhibit 49: O2 UK - Increase in CLV on Upgrade to Smartphone (£)



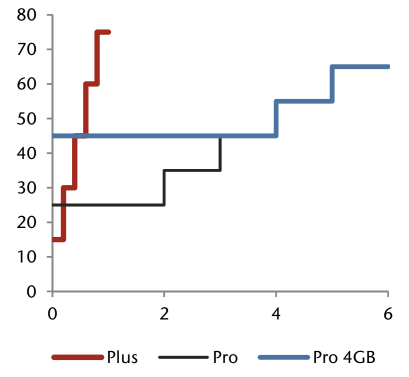
Source: Company data.

Current pricing structures vary widely

In the three charts below, we illustrate the amount (in US$) that smartphone contract subscribers on the AT&T, Vodafone UK and DoCoMo networks pay for data each month, depending on their level of consumption. Our analysis is based on current tariffs available on company Websites. It is immediately noticeable that the US/UK tariffs are heavily tiered. DoCoMo offers a variable plan, but it also continues to promote a flat-rate plan permitting (in theory) unlimited consumption.

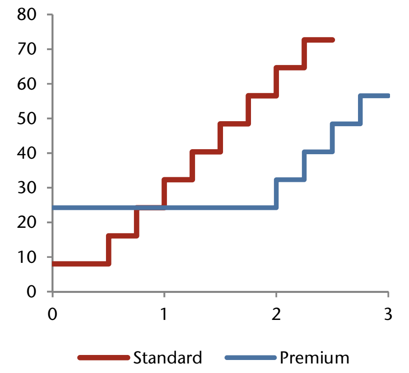
- **AT&T –** Entry point for low-usage customers is the $15 Data Plus package. However, this offers only 0.2MB/month, a level of consumption that will encourage even the average smartphone users to make heavy reliance on free WiFi connections. The steep step-up in Data Plus pricing as extra data allowances are bolted on seems intended to encourage migration to Data Pro, a package offering 10x the data allowance for an extra $10/month. There seems scope for more graduated tiers to be introduced for mid-usage customers.
- **Vodafone UK –** This more graduated approach is already in evidence here. Data allowances (usually 500MB/month) are bundled into most smartphone price plans (voice, messaging, data all integrated). Vodafone accounts for data revenue based on the pricing of standalone data bolt-ons, and this is the approach we have followed, too. The replacement value of a 500MB allowance is £5. A Premium bundle (£15 for 2GB) is also available. In both cases, overage is priced at £5 for every additional 250MB.
- **DoCoMo –** In Japan, mobile data consumption has traditionally been measured (and priced) based on the number of 128byte packets transmitted. The standard price plan (Pake-hodai double) charges a minimum monthly fee of ¥390 ($5). As consumption passes 4,650 packets, extra packets can be bought at the same per packet price, up until usage reaches 71,250 packets. To reach this point, a customer would need to be spending ¥5,985m ($77), which is a rather level equating to 112% of the average DoCoMo ARPU (for voice and data). Unlike AT&T and Vodafone UK, DoCoMo still offers an unlimited flat-rate plan (Pake-hodai flat). Whilst other operators focus on tiering to ease congestion, DoCoMo is guiding that it intends to promote flat-rate heavily in an attempt to stimulate ARPU growth.

Exhibit 50: AT&T Data Pricing ($) vs. Monthly Data Consumption (GB)



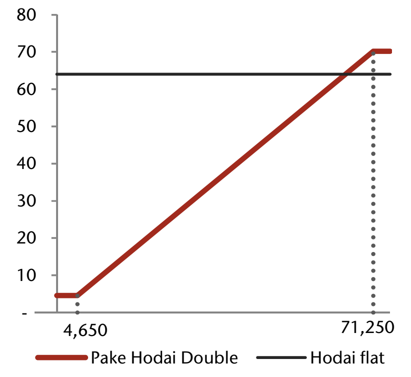
Source: Company data.

Exhibit 51: Vodafone UK Data Pricing ($) vs. Monthly Consumption (GB)



Source: Company data.

Exhibit 52: DoCoMo Data Pricing ($) vs. Consumption (packets)



Source: Company data.

Exhibit 53: China 3G Tariff Comparisons

China Mobile (CM) 3G plan			China Unicom (CU) 3G plan			China Telecom (CT) 3G plan			Attractive plan (w/o considering data speed)
Monthly fee	Nationwide airtime	Data included	Monthly fee	Nationwide airtime	Data included	Monthly fee	Nationwide airtime	Data included	
(RMB)	(minute)	(Mbps)	(RMB)	(minute)	(Mbps)	(RMB)	(minute)	(Mbps)	
			46 (A)	50	150M	49 (Lexiang all around)	100	200M	CT
			46 (B)	120	40M				
			46 (C)	260 (Local)	40M	49 (chat)	257 (Local)	100M	
58 (Unified)	150	30M				59 (Lexiang chat)	160	60M	CT
58 (Unified -2)	50	200M							
			66 (A)	50	300M				CU
			66 (B)	200	60M				
			66 (C)	380 (Local)	60M				
88 (G3)	200	500M	96 (A)	240	300M	89 (Lexiang all around)	60	500M	Competitive/ mixed
88 (Unified -2)	200	300M							
88 (Unified)	350	30M	96 (B)	450	80M	89 (Lexiang chat)	360	120M	
			96 (C)	550 (Local)	80M	89 (chat)	556 (Local)	100M	
128 (G3)	420	500M	126 (A)	320	400M	129 (Lexiang all around)	300	1G	Competitive/ mixed
128 (Unified)	650	30M	126 (B)	680	100M	129 (Lexiang chat)	660	120M	
128 (Unified -2)	420	400M				129 (chat)	992 (Local)	100M	
			156 (A)	420	500M				CU
158 (Unified)	900	30M	156 (B)	920	120M				
188 (G3)	750	500M	186 (A)	510	650M	189 (Lexiang all around)	400	2G	Competitive/ mixed
188 (Unified)	1200	30M	186 (B)	1180	150M	189 (Lexiang chat)	1200	120M	
						189 (chat)	1718 (Local)	200M	
228 (G3)	980	500M	226 (A)	700	750M				Depends
288 (Unified)	1900	30M							CM
288 (G3)	1300	1G	286 (A)	900	950M				
388 (G3)	2000	1G	386 (A)	1250	1.3G				Depends
388 (Unified)	2600	30M							
588 (G3)	3200	1G	586 (A)	1950	2G				Depends
588 (Unified)	4000	30M							
888 (G3)	4800	1G	886 (A)	3000	3G				Depends
888 (Unified)	6000	30M							

CM offers mid to high end users more voice minute with less data offering at same price.

CT's competitive advantage will emerge after handset value chain improves. On the low end, CT's 3G tariff plans are much more competitive vs. that of CU with more voice minutes and more data usage offers. On the mid-to-high end, CT has a clear lag compared to Unicom.

CU provides more comprehensive 3G plans with high end offers being most attractive.

Source: Company data; Jefferies & Co.

Is there hope for pricing power?

We are skeptical that telecom operators will be able to leverage mobile data appetite to regain (or retain) a degree of pricing power, except in rather isolated instances. In this section we run through the key issues.

- **Differentiated networks.** The success of AT&T and Verizon Wireless in driving mass-market adoption of data plans at about $30/month price points contrasts sharply against experience in Europe, where retail revenue growth has been flat (and more recently in slight decline) despite heavy smartphone adoption. In European markets, consumer perceptions of network quality across the different networks are arguably more uniform than in the US.
- **Vertical integration.** Historically, some operators tried to expand their influence in the value chain, for example by favoring their own-branded handsets and by setting up their own portals. But these initiatives have been short-lived. Consumers have been attracted by high levels of innovation and product differentiation in the handset space (contrasting against relative uniformity among networks), forcing operators to quickly appreciate the importance of offering the most complete portfolio of devices. Operators that lost sight of the fact that consumers are powerfully attracted the latest consumer electronics (such as Vodafone during 2008-09) found themselves losing significant amounts of market share. Going forward, we believe that opportunities for vertical integration will prove equally elusive. In most countries we believe that ongoing attempts by the branded device manufacturers to grab value will be difficult for operators to respond to given market structures.
- **Tariff transparency.** The shift to (simpler) integrated bundles will add more transparency to mobile pricing, in our view. This could encourage tariff optimisation. As falling MTRs enable smaller operators to price outgoing voice buckets more competitively, it seems possible the price points attached to integrated bundles could fall. In an environment where mobile revenue continue to decline at a market level, smaller operators retain a strong incentive to grow market share and avoid negative operating leverage associated with revenue decline.
- **Usage optimization.** We showed earlier in this section how Vodafone is seeing on-net traffic growth in Europe shrink to rather modest levels. We may now be reaching the point at growth in on-network data consumption needs to accelerate to justify stable ~20% growth in European data revenues. But with smartphone users accustomed to using free WiFi coverage as their default connection, it is not obvious how they can be persuaded to pay more for a monthly mobile data plan. Accelerating adoption of tablets may do little to support mobile data revenue since most are also configured to prioritize WiFi connections. While two-thirds of Apple iPads sold globally have 3G connectivity in addition to WiFi, experience in the US has seen many tablet customers using 3G as a "security blanket", consequently only taking out prepay data plans.

Experience in the U.S. has seen many iPad customers using 3G as a "security blanket," consequently only taking out prepay data plans

Focus on the small screen

We expect operators to focus their marketing effort on devices that offer the best return on investment. In Europe, operators promoted mobile broadband "dongles" heavily in

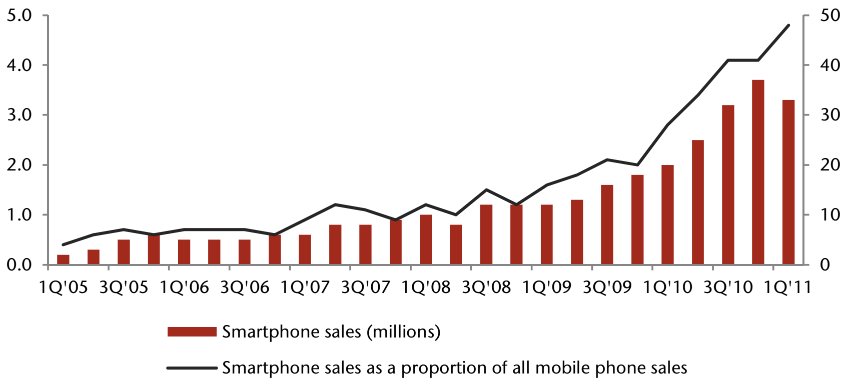
2008 and 2009, only to find yields dropped to very low levels given the undifferentiated nature of the product and an unhelpfully high degree of price transparency.

Vodafone disclosure from FY10 showed mobile data consumption from handsets generated almost 4x the revenue per MB of data consumed by dongles/data-cards (please see Jerry Dellis' report, "Vodafone: A More Resilient Cash Cow," dated 7/16/10). Dongles and data-cards still account for roughly 85% of data traffic on Vodafone European networks (according to management in November 2010) despite determined efforts to churn off some unprofitable high-users.

But the marketing focus has understandably shifted to smaller screen devices. The shift in emphasis is illustrated by Ofcom's analysis of mobile broadband in the UK. Dongles and data-cards rapidly reached 12% penetration of UK households by March 2009, but the pace of growth is now slowing with 15%/17% reached in March 2010/March 2011, respectively.

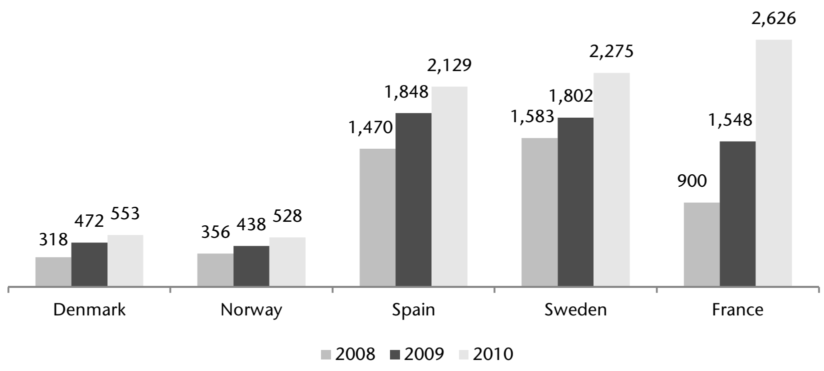
Accelerating growth in tablet volumes poses a dilemma since tablets are likely to stimulate dramatically higher consumption levels than smartphones. Faced with a device creating a strong consumer pull, operators cannot simply fail to support it adequately for fear of losing market share. Vodafone argues that tablet customers are likely to place heavy reliance on WiFi networks, mirroring their smartphone behavior. The flipside of such reliance, of course, is that customers may see less need to subscribe to high-value data plans. We have noted the heavy take-up of prepay plans by tablet users in the United States.

Exhibit 54: UK Smartphone Sales



Source: Ofcom; Jefferies & Co.

Exhibit 55: Machine to Machine Subs 2008-2010



Source: National regulators; Jefferies & Co.

Ways to Play Mobility Trends in the Telecommunications Services Sector

China Unicom and Vodafone are plays on secular growth in mobility

- **China Unicom (Buy)** is our top pick in the Chinese telecom services space. In the 2G era, China Unicom was the laggard operator with most of the low-end users in China. Since the 2008 industry-wide restructuring and 3G license issuance from the Chinese government, China Unicom became the country's only WCDMA network operator with the strongest vendor support in smartphone handset selections, and the fastest, most reliable 3G networks.

  We view Unicom as the structural beneficiary of industry market share shift from China Mobile, and it is the best telecom play to benefit from the consumption upgrade in wireless data. We expect Unicom's revenue, EBITDA and net profit to grow at a 2011-13E CAGR of 16.2%, 18.2% and 78.9% respectively, the highest among the three Chinese carriers.

- **Vodafone (Buy)** offers a 13.5p dividend this year (8.2% yield), and this is still only a 70% pay-out on equity FCF. Vodafone recently announced a 4p special dividend increasing current year distributions by 42%. Verizon's latest dispute with unionized employees in its wireline division underlines the challenges of maintaining cash flow there and in turn underlines why the VZW dividend can confidently be considered recurring. Vodafone operations are typically number one or two players in most markets, giving Vodafone access to early adoption of mobile data customers. Following a period of operational underperformance in 2008/2009, we believe that management fully appreciates the importance of maintaining a strong portfolio of mobile data devices, and sustained network investment has always been a priority. Therefore, we believe Vodafone is well placed to monetize mobile data as effectively as any other peer group.

TeliaSonera and France Telecom are challenged by secular growth in mobile data

- **TeliaSonera (Underperform).** The Swedish mobile market already faces one of the highest mobile data penetrations in the world (83 mobile broadband subscriptions per 100 inhabitants according to OECD definitions). This naturally limits any upside one might expect even based on a more upbeat analysis than the one we put forward in this section. A particular risk for TeliaSonera is that the strong growth in mobile broadband has so far not been accompanied by a commensurate disconnection of fixed lines. After all, mobile-only household penetration in Europe is running at about 27% on average in the EU27 but only 2% in Sweden (per the European Commission's Eurobarometer 362, July 2011). We believe the high penetration of mobile broadband in Sweden destabilizes this unusually high fixed-line penetration. If customers (in certain segments, such as lower-income single-person households) can satisfy all of their communications needs including Internet access through mobile, then fixed penetration should normalize to levels seen elsewhere in Europe. We therefore believe TeliaSonera (as the fixed-line incumbent) is likely to experience material cannibalization from mobile broadband in its fixed business while the matching upside already lies largely in the past.

- **France Telecom (FTE FP, €13.30, Underperform)** faces a competitive four-player domestic mobile market, including a new entrant set to intensify competition through challenger tactics. We see a particular vulnerability caused by high retail spend on mobile telephony in the French market: At €28.8 per month per capita in the twelve months to March 2011, the French mobile spend is at one of the highest levels in Europe (see Jerry Dellis' report, "Telecom Services: Catalysts for further downgrades in 2H," dated 6/13/11). We argued earlier in this section that pushing smartphones into the subscriber base necessarily requires tariffs bundling voice/data allowances, in order to avoid voice-data arbitrage by subscribers. A by-product of this bundling is higher tariff transparency, which may well trigger tariff optimization in particular by higher-spending subscribers such as the French. In other words, the French mobile market faces particular repricing risk created by a coincidence of competitive dynamics (new entrant), opportunity (high spending levels), and driving force (tariff bundling imperative). We therefore believe FT is unlikely to be a beneficiary of mobile data growth.

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The Infrastructure Requirements of An Increasingly Mobile World

Executive Summary

Mobile Data Bandwidth Demand Will Grow 100x by 2020. As we consider the potential state of the mobile infrastructure market in 2020, we begin our analysis with the key underlying driver: mobile data growth. Our conclusion: Mobile data demand will grow by at least 100x over the next nine years. This massive growth has significant implications for the network, in our view. Moreover, we expect that a tectonic shift in the network design required to handle this growth will create winners and losers among communications equipment vendors over time. Among our major conclusions:

1) **Demand for mobile bandwidth will increase over 100x by 2020.** A major piece of the growth comes from subscribers' shift from feature phones and traditional smartphones to highly bandwidth-intensive "super" smartphones (like iPhones and Android-based phones). The migration of Web-based video content from low resolution to high resolution will also drive a big portion of this bandwidth growth.

2) **Carriers will use a variety of techniques to handle this bandwidth growth.** Based on our analysis, there is no silver bullet. Operators will use a combination of tools to manage growth including: 1) acquiring new spectrum; 2) deploying more efficient wireless technologies/algorithms like LTE and LTE Advanced; and 3) aggressive use of cell splitting. Other techniques include the more aggressive use of tiered mobile data pricing plans. We believe no single solution can alone solve this problem.

3) **Small form factor RAN infrastructure is the key...** We see wireless RAN (regional area network) infrastructure changing dramatically. Operators will have to deploy large numbers of small form factor RAN devices and perhaps femtocells to accommodate bandwidth growth (note the hesitation our telecommunications services analysts have regarding femtocell deployment elsewhere in this report). WiFi, in our view, will also become an important part of the solution.

4) **LTE will be the dominant air interface for the installed base of subscribers in 2020.** We believe that any "5G" technology, if it develops, will be slow to roll out and only provide incremental improvements in network capacity.

5) **Wireless networks have to get much, much cheaper on a cost-per-bit basis.** In addition to the techniques we've outlined above, we expect that IMS (and convergence) will get rolled out within wireless networks. Similarly, Policy and Subscriber Data Management will be important tools for operators.

6) **We expect dramatically higher level of mobility in 2020 to drive semiconductor growth** across three broad classes of end markets: Mobile Terminals, the Cloud/Data Center, and the Communications Infrastructure that connects those two end points of the network. Our top mobile terminal picks are Avago, Broadcom, and Murata. Our data center/cloud semiconductor plays

are Intel, AMD, and PMC-Sierra, and our communications infrastructure picks are Altera, Inphi, and NetLogic.

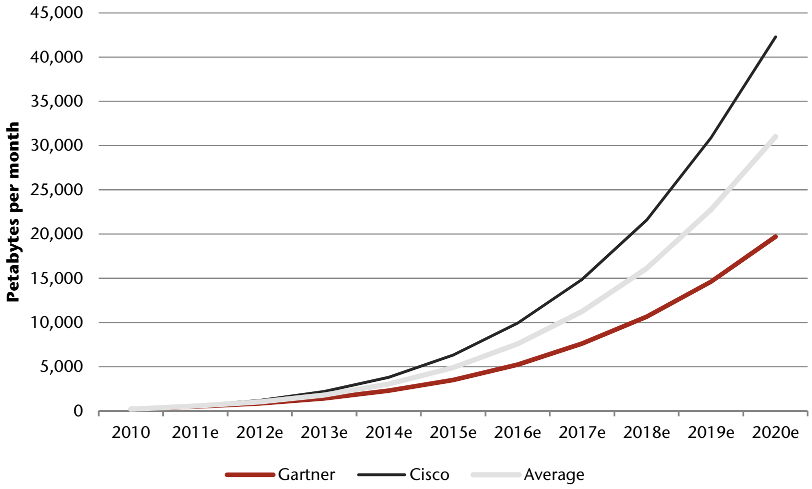
7) **We expect that Alcatel-Lucent, Broadsoft, Juniper, and Tekelec should be significant beneficiaries** of the pending transformation within wireless networks.

Mobile Data Growth Analysis – is 100x possible?

What Others Are Saying … We highlight mobile data traffic growth projections from Cisco and Gartner in the chart below. Cisco's Visual Networking Index (VNI) in particular provides a very strong argument for tremendous ongoing growth in overall network traffic. With the VNI forecast, the equipment provider attempts to forecast traffic growth using a variety of assumptions including market research analyst projections for Internet users, broadband connections, video subscribers, mobile connections, and Internet application adoption. Cisco also layers in its own usage assumptions for minutes of use and kilobytes per minute. Fundamental enablers like broadband speed and PC computing power are factored into the analysis as well. Separately, the organization "gut checks" its VNI traffic forecast with actual traffic usage metrics and is working with 20 major service providers globally to capture actual network traffic statistics. Cisco installs its Service Control Engine platform at various points in service providers' networks where Cisco's technology can passively collect data on the types and amounts of IP network traffic crossing networks. Cisco's work covers core network IP traffic growth as well as mobile data network growth. We've highlighted their mobile numbers below.

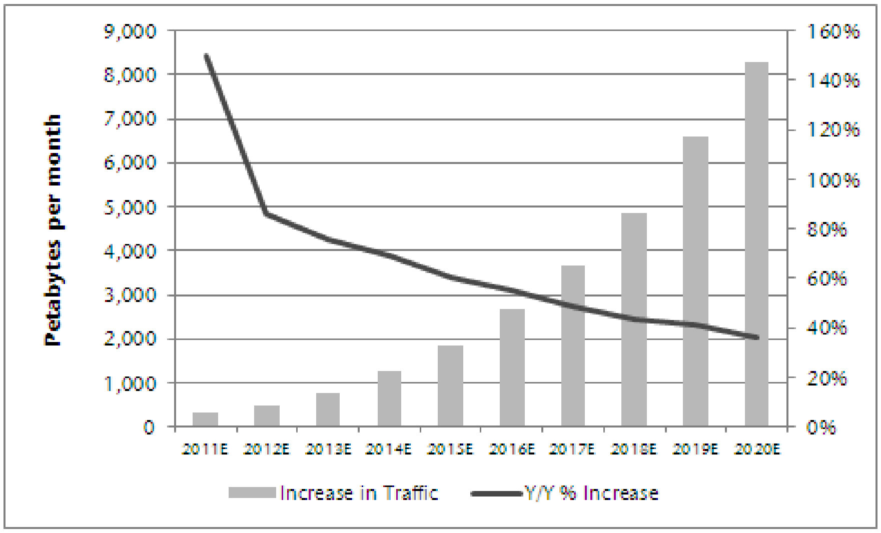
We have extrapolated Cisco and Gartner's growth trends and have extended their forecasts through 2020. We have assumed that mobile data growth rates continue to moderate post 2015. In the exhibit below, we also highlight the "second derivative" effect, which is the absolute change in aggregate mobile data traffic on communications networks. The key takeaway for investors is that the growth of mobile data traffic – in absolute terms (i.e., the "second derivative affect") – has the potential to remain very robust for many years to come (still nearly 40% in 2020). Intuitively, this makes sense to us; we do not see mobile data growth slowing down any time in the foreseeable future given the continued adoption of wireless broadband, ever-increasing mobile broadband speeds, and the many nascent applications that are emerging for wireless technology.

Exhibit 56: Global Mobile Data Traffic Forecast (2010 – 2020E)



Source: Cisco Visual Networking Index, June 2011; Gartner Research; Jefferies & Co. estimates.

Exhibit 57: Global Mobile Data Traffic Forecast (2010 – 2020E)



Source: Cisco Visual Networking Index, June 2011; Gartner Research; Jefferies & Co. estimates.

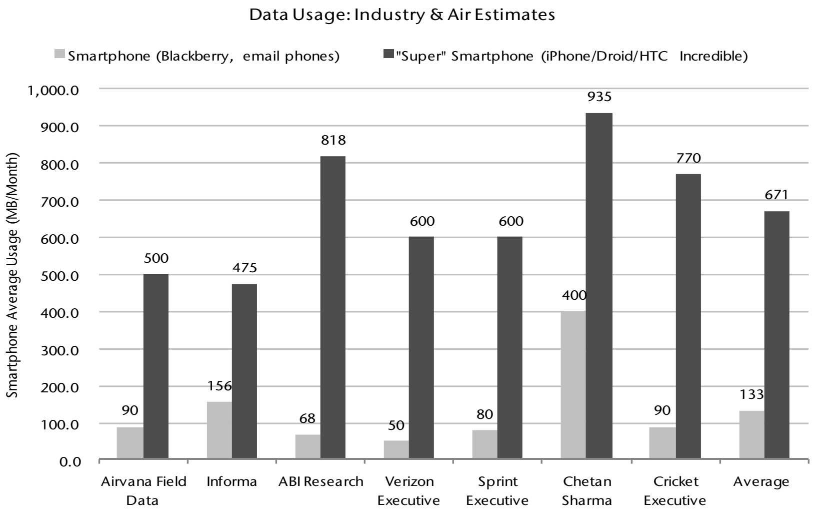
“Gut Check” on Data Growth – 100x May Be Conservative

To “stress test” the projections above, we performed a “bottoms-up” analysis of mobile bandwidth growth. Our analysis considers two key variables:

- **“Same Store Sales” Growth on Each Type of Device/Handset:** How many users of each type of mobile device (2G, 3G, 4G, etc.) will grow their mobile data consumption from now through 2020
- **Subscriber Mix Shift:** How mobile data consumption will grow as a result of subscribers migrating from 2G to 3G to 4G devices

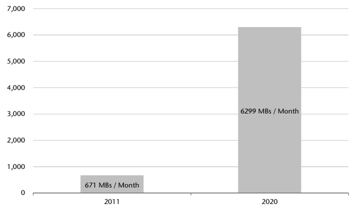
A Snapshot of Current Mobile Data Usage… As a starting point, we note that current mobile data usage patterns vary significantly within the existing smartphone user base. This is shown in the exhibit below. Averaging data points from a number of sources, mobile data consumption of the average “super” smartphone users (which essentially consists of iPhone and Android users) is currently around 671 MBs/month. This compares to 133 MBs/month for the “non-super” smartphone user (largely Blackberry and other “email”-centric phones).

Exhibit 58: Mobile Data Usage, Smartphone vs. "Super" Smartphone (ex-Wifi offload)



Source: Airvana.

Exhibit 59: "Super" Smartphone User Mobile Data Consumption (MBs/month): 2011 vs. 2020



Source: Airvana

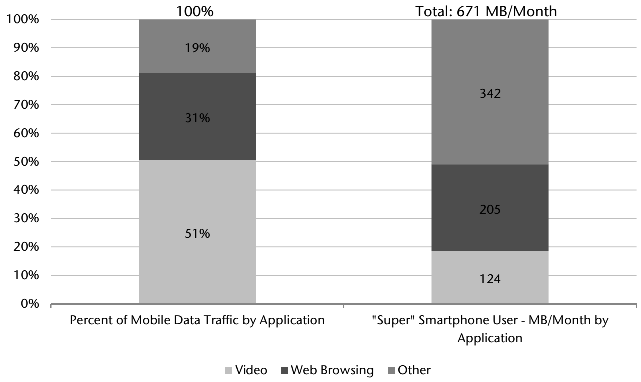
We Project a "Super" Smartphone User's Mobile Bandwidth Could Increase 9x by 2020... As mentioned above, we began our analysis by first examining the potential growth in mobile data consumption of the heaviest smartphone users today. We believe that the primary driver of growth in mobile data usage over the 2011-2020 time horizon will be video. To drive our estimates of 2020 "super" smartphone data usage, we examined the impact of a shift in the mix of video traffic from video formats below "full" HD (1080p) to 100% 1080p. While we acknowledge that today's smartphones don't currently support native 1080p playback, we believe it is safe to assume that this will change by 2020. For example, we understand that LG Display, Toshiba, and other panel manufacturers are planning to release handset/smartphone panels that will support native 720p resolution next year. It is conceivable, even likely we believe, that handheld wireless devices will have migrated from 720p to 1080p resolution by 2020. One counter-point to our view is that – on small screen sizes – consumers can't readily distinguish between 720p and 1080p quality resolution. We note, however, that display technology is evolving at a very rapid pace. Our expectation is that, over time, 1080p displays approach, or go below, cost points for 720p, at which point manufacturers might as well include 1080p displays. Moreover, "perception is reality" from a marketing perspective. As such, wireless device makers (driven by Apple) will increasingly make screen resolution a point of competitive differentiation – regardless of whether or not consumers can tell the difference between 720 and 1080 on small screens. In the chart below, we have segregated the portion of mobile data traffic that is video. The following chart further illustrates the mix of video traffic by video format/resolution.

From a content perspective, it is clear that more and more video content will increasingly get created in higher resolutions. Today's video recording devices commonly record in

1080p formats. More and more video is getting posted to sites like Youtube.com as increasingly high resolution content. We also note that other formats that are even more data-heavy than 1080p (Ultra-HD, 3D, Holographic, etc.) could emerge. Also, by 2020, it is conceivable that subscribers will commonly have video projection capabilities embedded into their wireless devices (see the section of this report on form factor). For example, users could project movies and other content onto a wall for viewing. This would further drive the need to deliver 1080p content over wireless networks.

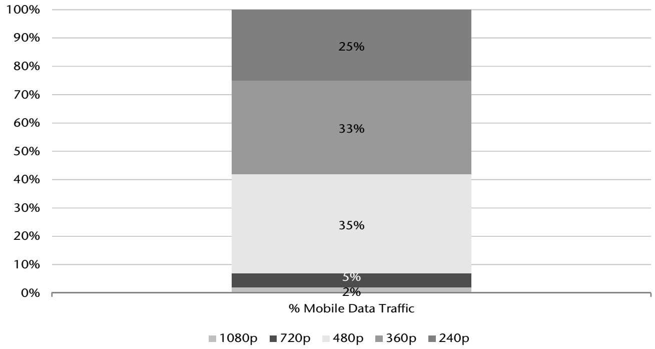
For Web Browsing and “Other” mobile data traffic (e-mail, etc.), we are conservatively assuming 10% growth per year until 2020. Our assumptions are depicted in further detail in the exhibit below. The end result of our analysis is that, by 2020, we estimate that “super” smartphone users will consume 5.7 GB/month – nearly 9x current bandwidth consumption levels for these devices.

Exhibit 60: Mobile Data Traffic by Application



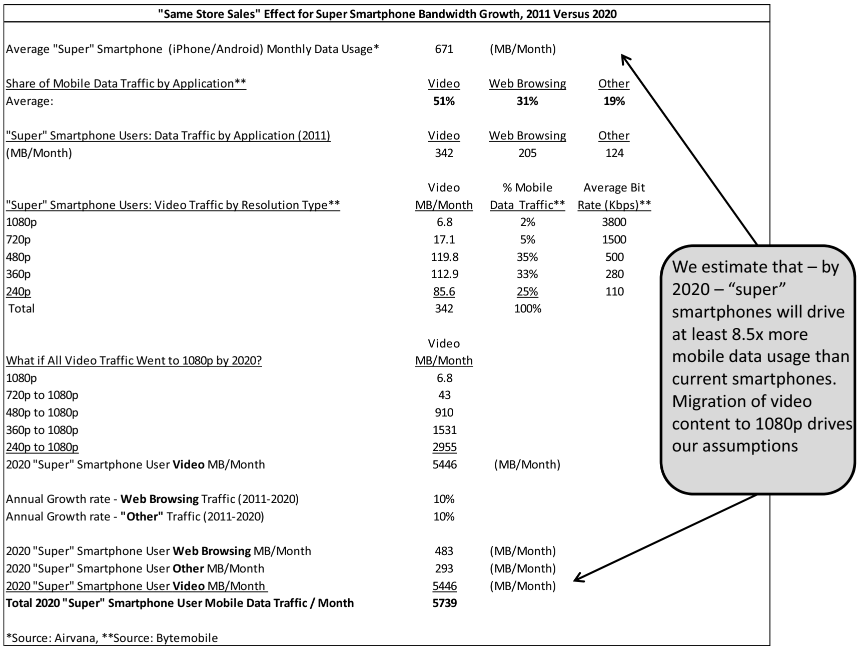
Source: Bytemobile; Jefferies & Co.

Exhibit 61: Video Traffic by Video Resolution/Format



Source: Bytemobile; Jefferies & Co..

Exhibit 62: Mobile Data Usage, Smartphone vs. "Super" Smartphone (ex-Wifi offload)



"Same Store Sales" Effect for Super Smartphone Bandwidth Growth, 2011 Versus 2020

Average "Super" Smartphone (iPhone/Android) Monthly Data Usage*	671	(MB/Month)	
Share of Mobile Data Traffic by Application**	Video	Web Browsing	Other
Average:	**51%**	**31%**	**19%**
"Super" Smartphone Users: Data Traffic by Application (2011)	Video	Web Browsing	Other
(MB/Month)	342	205	124
"Super" Smartphone Users: Video Traffic by Resolution Type**	Video MB/Month	% Mobile Data Traffic**	Average Bit Rate (Kbps)**
1080p	6.8	2%	3800
720p	17.1	5%	1500
480p	119.8	35%	500
360p	112.9	33%	280
240p	85.6	25%	110
Total	342	100%	
What if All Video Traffic Went to 1080p by 2020?	Video MB/Month		
1080p	6.8		
720p to 1080p	43		
480p to 1080p	910		
360p to 1080p	1531		
240p to 1080p	2955		
2020 "Super" Smartphone User **Video** MB/Month	5446	(MB/Month)	
Annual Growth rate - **Web Browsing** Traffic (2011-2020)	10%		
Annual Growth rate - **"Other"** Traffic (2011-2020)	10%		
2020 "Super" Smartphone User **Web Browsing** MB/Month	483	(MB/Month)	
2020 "Super" Smartphone User **Other** MB/Month	293	(MB/Month)	
2020 "Super" Smartphone User **Video** MB/Month	5446	(MB/Month)	
Total 2020 "Super" Smartphone User Mobile Data Traffic / Month	**5739**		

*Source: Airvana, **Source: Bytemobile

We estimate that – by 2020 – "super" smartphones will drive at least 8.5x more mobile data usage than current smartphones. Migration of video content to 1080p drives our assumptions

Source: Bytemobile; Airvana; Jefferies & Co. estimates.

Turning to other categories of devices, we have also made "same store sales" assumptions about how these subscribers/devices grow bandwidth usage between now and 2020. We have summarized our assumptions in the exhibit below. With estimates of "same store" device growth now in place, the rest of our analysis is based on the anticipated mix between these devices in the future.

Exhibit 63: Mobile Data Bandwidth Usage/Subscriber/Month by Device Type, (MB/month) (2011 – 2020E)

	2011	2020	Assumptions / Notes
Feature phone	5	5	These handsets are only sold into very low GDP areas of the world in 2020
"Super" Smartphone	671*	5739	See prior Exhibit for our assumptions. Excludes WiFi-based mobile data traffic.
"Regular" Smartphone	133	NA	We assume that all traditional Blackberry-like devices transition into "Super Smartphone" devices
4G phone	2000	10000	Jefferies assumption. There's very little current data on 4G/LTE data usage rates
Tablet PC	400	3421	Excludes WiFi-based mobile data traffic. This is driven by higher resolution video traffic formats.

Source: Bytemobile; Airvana; Jefferies & Co. estimates.

Subscriber Mix Shift Combined With User Growth Drives Nearly 100x the Mobile Data Traffic… The second major variable we examined in the growth of mobile data is the mix shift globally from 2G to 3G and 4G devices. In the table below, we highlight Jefferies' estimates for the installed base of subscribers by technology on a global basis. Coupling these assumptions with the usage by subscriber assumptions described above, we arrive at the global mobile bandwidth projections in the chart below. In total, we estimate that 2020 mobile data traffic could increase at least 100x from 2011 levels.

Exhibit 64: Global Subscriber Data - Installed Base of Wireless Subscribers by Device Type

Generation	2009	2010	2011	2020
2G Subscribers	3,704	3,962	3,928	1,498
3G Subscribers - "Super" Smartphones	25	140	415	4,287
3G Subscribers - "Regular" Smartphones	845	1,010	1,023	0
4G Subscribers	0	1	8	1,813
Tablet PCs (excludes-WiFi only tablets, ~50%)	0	9	44	800
Total	**4,574**	**5,123**	**5,419**	**8,398**

Source: Jefferies & Co. estimates.
Note: Actuals through 2010

Exhibit 65: Global Mobile Bandwidth Traffic by Device Type (2011E – 2020E) (MB/Month) (in millions)

Generation	2011	2020
Feature phone	19,642	7,490
"Super" Smartphone	278,465	24,603,595
"Regular" Smartphone	136,098	0
4G phone	16,833	18,128,167
Tablet PCs (excludes-WiFi only tablets, ~50%)	17,600	2,736,922
Total	468,639	45,476,173
Total Mobile Data Bandwidth Growth (2011 versus 2020)		**97.0x**

Source: Jefferies & Co. estimates.

We're probably too conservative… Our analysis relies on a number of key assumptions. Perhaps the most important implicit assumption is that technology and carrier business models evolve to provide these robust increases in mobile data capacity in an economically feasible way. Overall, we believe there are a number of factors that could drive upside to our estimates for mobile data growth: 1) handsets/handset displays evolve to support 1080p video transmission; 2) all traditional 3G smartphone users ultimately become "super" smartphone users; 3) the overwhelming proportion of bandwidth consumption remains downstream (not upstream); and 4) all video content on Youtube/other video sites are recorded/stored in 1080p resolution.

The applications that may consume the most mobile data capacity in the future may not even have emerged yet…

There are a number of potential variables that we ignored in our analysis for the purposes of simplification. Excluded variables include: 1) all machine-to-machine (M2M) traffic; 2) any as-yet unknown applications that will drive additional bandwidth consumption; 3) notebook PC mobile data growth; 4) data growth from non-phone gaming devices; 5) any voice traffic growth (or the proliferation of HD voice); 6) any substitution of voice traffic by video conferencing / any major increases in upstream traffic demands; 7) any 3D video traffic; and 8) any transformative applications / product developments. On balance, it seems the factors we've excluded here could present significant incremental drivers of mobile bandwidth growth. It also seems likely to us that the applications that may consume the most mobile data capacity in the future have not yet emerged in the market place or perhaps have not even been contemplated. Nonetheless, our analysis gives us confidence that the data projections we have made above – at least from a demand standpoint – are not unreasonable.

To reinforce the notion that our estimates may be too conservative, we note that Alcatel-Lucent's Bell Labs organization is modeling 30x bandwidth growth by 2015 and 500x bandwidth growth by 2020. Regardless of whether the actual figure winds up at 100x or 500x, we can conclude that today's wireless networks will have to undergo a massive transformation in order to accommodate future traffic. Our discussion now turns to what that network will look like in 2020.

How Will the Network of the Future Adapt to All this Data?

We expect that by 2020 mobile data growth will have forced operators through a major network transformation

We expect that by 2020 mobile data growth will have forced operators through a major network transformation. Wireless networks will look very different than we are used to today. These changes remind us of the late 1990s, when the major transformation from dial-up Internet access to broadband Internet access was taking place. At that time, vendors like Ascend, U.S. Robotics, and Shiva gave way to emerging players like Advanced Fibre, Juniper, Redback, and Cerent as operators struggled to keep up with Internet data growth. Many billions of dollars in market capitalization were won and lost. Looking ahead, we expect this major transition in wireless infrastructure to have similarly profound implications for network equipment vendors. Below, we have detailed the major components of our view on this pending wireless transformation – all driven by growth in wireless data.

To handle data growth, the economics of wireless capacity additions have to be reduced dramatically

Wireless networks have to become much lower cost… We note that annual price declines for communications infrastructure (holding technology constant) have historically run in the 15%-20% range. For the sake of argument, if we assume that mobile data traffic growth will progress as we have outlined above (increasing roughly 100x between 2010 and 2020), and assume annual price erosion of 17.5%, this would imply a 2020 market size of $875 billion. This is roughly 20x the 2010 mobile infrastructure market of $42.6 billion estimated by Infonetics Research that currently carries roughly 220 petabytes of data per month. Obviously, the economics of telecom services could never support such a huge annual investment in infrastructure. To handle this data growth, the economics of wireless capacity additions have to be reduced dramatically. As discussed in more detail below, we expect that communications infrastructure technology will have to deliver dramatic reductions in cost per bit transported to enable this robust data growth.

The three major ways to "solve" the wireless data problem… There are three key levers that operators and equipment vendors can "pull" to increase mobile data capacity: 1) more spectrum can be made available; 2) wireless technologies can become more spectrally efficient; or 3) operators can re-use existing spectrum more aggressively by reducing cell coverage areas.

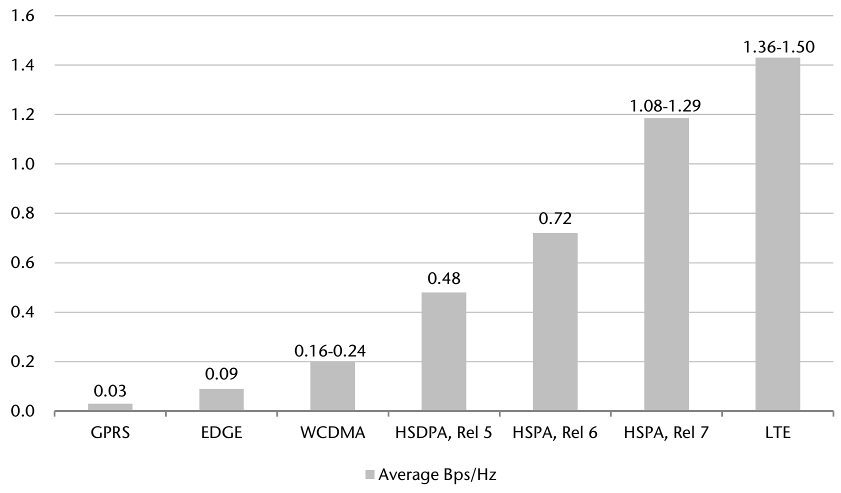
The Spectrum Shortage… It is clear to us that more spectrum is needed to accommodate the increase in broadband traffic. In the United States, The National Broadband Plan advised the FCC to make an additional 500 MHz of spectrum available for mobile broadband – 300 MHz by 2015 with an additional 200 MHz available by 2020. This recommendation was based on an analysis from the FCC OBI (Omnibus Broadband Initiative) that indicated that there would be a shortfall of spectrum of 95 Mhz by 2012 and 250Mhz by 2014. The proposed plan roughly doubles the 547 MHz currently licensed for mobile broadband. Even using conservative estimates, it seems that spectrum will become an increasingly scarce resource as the explosion of mobile data traffic continues. Of course, AT&T's proposed acquisition of T-Mobile USA – a stated objective of which is to increase AT&T's spectrum holdings – supports the notion that there is a long-term dearth of available spectrum.

Efficiency Gains Will Help… Another source of mobile broadband capacity comes from fundamental improvements in wireless technology. Improvements in the efficiency of algorithms (such as LTE) will help drive increased throughout in the RAN. In other words, we can modulate more bits per unit of spectrum as the technology gets better. We believe modulation techniques will improve, but unfortunately, there are limits to these kinds of improvements. A common view in the industry is that there will be diminishing returns on the size of further efficiency improvements. Shannon's Law – which establishes the mathematical relationship between signal power, interference, and throughput – calculates the cap on the amount of throughput that can be derived through a given amount of frequency. Of course, realized transmission speeds in wireless networks are significantly below their theoretical limits due to noise/interference. Based on conversations with industry contacts, we understand that it is reasonable to expect 2x potential improvements (relative to LTE) in spectral efficiency from new algorithms beyond LTE.

Ericsson forecasts that by 2020, 50 billion devices will have wireless connectivity

LTE Drives Gains in Spectral Efficiency… In the RAN, there is a push for carriers worldwide to deploy to LTE/4G mobile networks. Each new generation of wireless protocol becomes more spectrally efficient, thereby requiring less RAN infrastructure for a given amount of traffic growth (see chart below). The FCC projects (in their OBI Technical Paper Series, "Mobile Broadband: The Benefits of Additional Spectrum," October 2010) that average spectral efficiency will approximately double between 2009 and 2014, from 0.625 bps/Hz to 1.25 bps/Hz, via increasing LTE penetration. The FCC assumes that spectral efficiency is "approaching maximum expected limits," but we note that Ericsson projects theoretical spectral efficiencies (peak downlink rate per Mz) to increase by ~7x between 2010 and 2014. Nonetheless, additional improvements in wireless technology efficiencies should come to some degree as modulation techniques continue to advance and other technologies, such as MIMO, evolve.

Exhibit 66: Average Downlink Spectral Efficiency by Technology



Source: Federal Communications Commission, OBI Technical Paper, *"Mobile Broadband: The Benefits of Additional Spectrum,"* October, 2010.

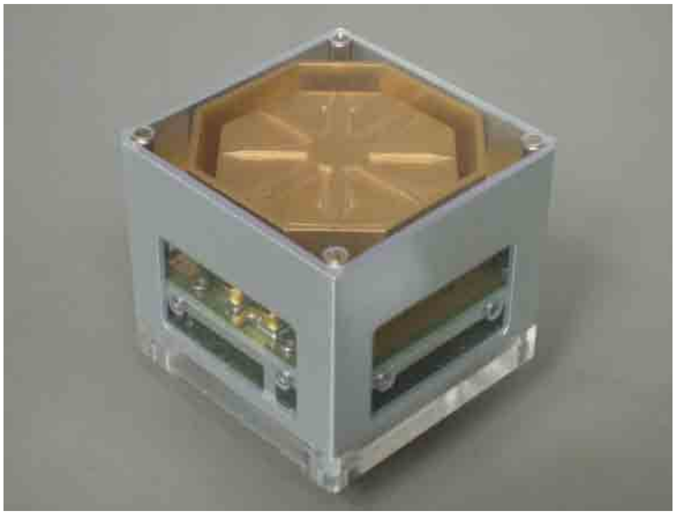
Another important benefit of reducing the radius of cell sites is that it improves spectral efficiency

Cells Have to Get Smaller… In our opinion, the mobile data problem can't get solved by a combination of new spectrum availability and simple improvements in spectral efficiency of the technology. Doing some "back of the envelope" math, if the aggregate mobile data traffic load increases 100x, available spectrum doubles, and efficiency increases "as much as" 2x, more capacity will be still be needed (on the order of 25x). We therefore expect that operators will also increasingly decrease the size of the "cells" in wireless networks to accommodate bandwidth growth. Stated differently, operators will have to "re-use" their available spectrum more aggressively by deploying more, smaller-radius cell sites. This trend, of course, is not new – operators have been "splitting" cell sites for years. Another important benefit of reducing the radius of cell sites is that it improves spectral efficiency (i.e., noise becomes less of an issue at short distances from the radio).

Municipalities Versus Cell Towers – The Infrastructure Has to Shrink as Well… As evidenced by a number of industry anecdotes, operators have faced some difficulty in increasing the number of cell towers, particularly in dense urban areas (arguably where new cell towers are most needed). Traditional large, macro towers are expensive, take up a great deal of space, and are generally not well-received by the communities where they are to be installed given the potentially negative aesthetic impact.

Products like Alcatel-Lucent's lightRadio and Ericsson's AIR, both of which were introduced at Mobile World Congress earlier this year, are antenna integrated, compact solutions that stand to alleviate the issues associated with continuing build outs of macro cell towers. lightRadio is a joint project between Alcatel-Lucent, Hewlett Packard (HPQ, $26.03, Buy), and Freescale (FSL, $11.50, NC) Semiconductor. The technology distributes some of the key base station functions in different portions of the network with the aim of replacing "today's jungle of large overcrowded cell site towers." In a lightRadio cube, cellular antennas fit into small, multi-standard units that can be installed in a variety of locations; the lightRadio product fits in a cube with 6 centimeter sides. lightRadio also moves much of the traditional processing capabilities away from the cell site and into the Cloud. The product can be powered by wind, sun, or electricity, which helps to reduce total cost of ownership by 50% and allows operators to use existing infrastructure to backhaul traffic. Similarly, Ericsson's AIR product involves the integration of the mobile antenna into the radio device. Mainly through reduced feeder loss and simplified cooling, the AIR has been tested to reduce power consumption by up to 42%. Alcatel-Lucent estimates that the addressable market for these small form factor radio products will total €12 billion by 2014. The picture below is of the lightRadio product from Alcatel-Lucent.

Exhibit 67: Alcatel-Lucent's lightRadio



Source: Alcatel-Lucent.

Wi-Fi and Femtocell Offload Will Increase in Importance… As previously mentioned, Wi-Fi and Femtocell offload represent two other options available to carriers to relieve strain on their mobile networks. We expect that these "offload" solutions will be increasingly utilized by carriers, and that technology will evolve to make the handoffs between carrier and Wi-Fi networks largely transparent to the end user. Again, this offloading can be achieved by customers offloading their mobile traffic to their broadband connection via their home Wi-Fi router, through wide area WLAN networks offered by carriers, or through municipal Wi-Fi networks. AT&T, for example, utilized Wi-Fi data offload in the United States after experiencing problematic data congestion in urban areas, particularly after the launch of the iPhone. AT&T employs roughly 27,000 Wi-Fi hotspots nationwide across congested, urban areas. Wi-Fi hotspots are designed to reduce traffic load in busy, capacity strained areas. Verizon recently announced its plans to make a similar (although much smaller) Wi-Fi investment, focusing on high-traffic areas such as hotels and campuses. While Wi-Fi solutions are cheaper to deploy on an individual installation basis, the number of required installations is often substantially greater. We note that Wi-Fi offload as a percentage of total data load is relatively small. As this proportion grows larger, we expect issues to emerge regarding the licensing, rights, and costs of backhauling the traffic through a broadband network.

Femtocells are small cellular base stations designed for use in a home or small enterprise. They connect to carriers' networks via broadband connections and they are normally capable of providing two to four active mobile phones with service (in a household setting, for example). Conceptually, they are similar to wireless access points but instead of emitting a Wi-Fi signal, they emit GSM/WCDMA, CDMA, and/or LTE RF signals. Femtocells have faced headwinds in gaining meaningful acceptance in the consumer market. This is in large part due to business model issues: Customers have been hesitant to pay for femtocells, and carrier subsidization does not often make economic sense in markets where consumers churn frequently. Similarly, integrated (wireline + wireless) operators have a harder time with the economics of femtocells. In situations where the subscriber buys both wireline and wireless services from an operator, a femtocell deployment in their home may encourage the customer to drop their landline service. Nonetheless, we expect femtocells to be increasingly adopted to some degree over time as these business model issues are worked out. Elsewhere in this report, our global telecommunications services analysts note other headwinds that femtocell deployment has faced worldwide.

Small Form Factor Radios will Leverage the Cloud… One of the key technology advances that will allow vendors to design small, scaled-down RAN infrastructure is the development of the Cloud. Here, the baseband signal processing that has historically been performed at the edge of the network with larger, macro Node B wireless radios can be moved into the Cloud. For example, in large metro areas, the operator may elect to deploy small form factor radios on lamp posts or traffic lights. Here, the limited available space and the size of the radios are key design factors. These radios might be designed simply with certain RF processing functions designed into a small antenna. Baseband processing tasks are performed in the Cloud. Besides a space and power savings at the radio site, this network design takes advantage of the fact that wireless traffic loads can be highly variable (especially on individual small form factor radio systems). Hence, the processing capacity made available in the Cloud can be sized appropriately – i.e., it handles the traffic load in business centers during the day and residential areas in the evenings.

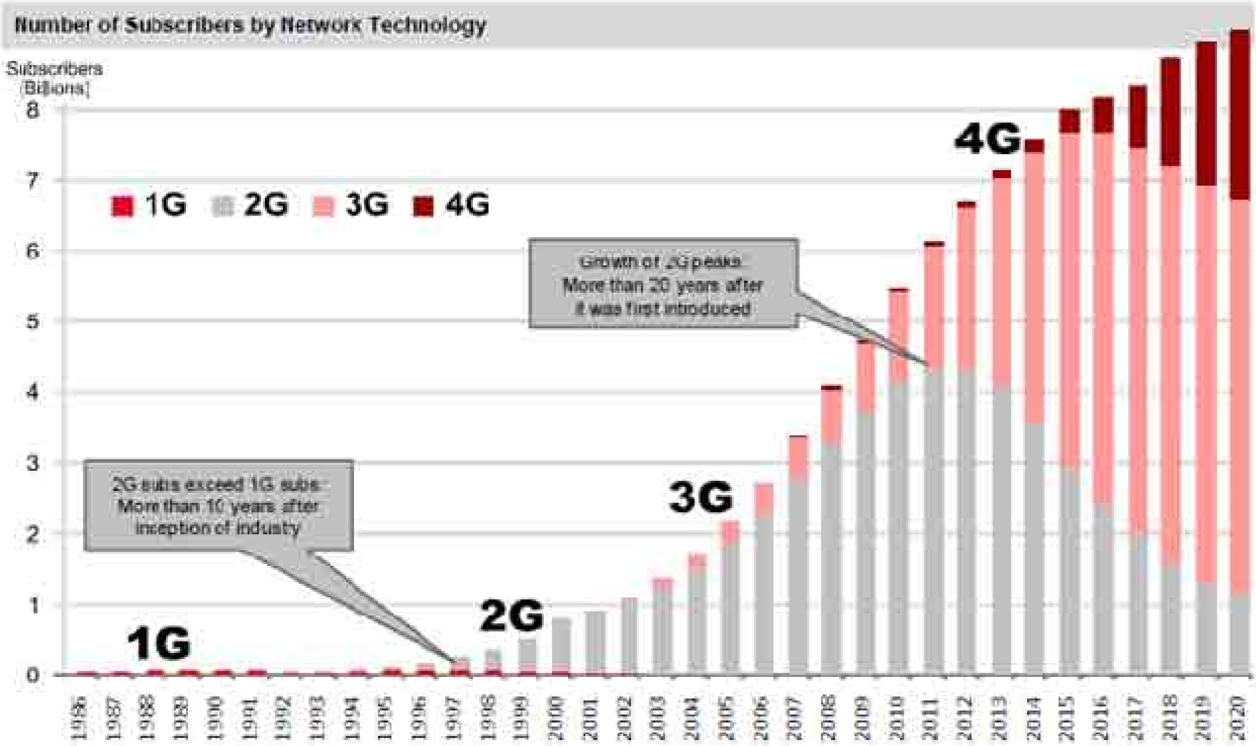
There is no "one-size fits all" solution, however. In cases where the radio is a residential femtocell, for example, it is not accommodating much traffic. Hence, there is not much advantage to backhauling the baseband processing functions back to the Cloud. Similarly, in rural areas (where operators have low capacity requirements and plenty of space to locate large, macro Node B systems), there is not much of an advantage to using the Cloud.

LTE Will Be the Dominant Wireless Technology in 2020…We expect that LTE will be the dominant wireless technology that will be in the process of deployment in 2020. We note that the underlying technology transitions (e.g., 2G to 3G, 3G to LTE) take many years to develop. A significant driver of this dynamic is the slow migration of subscribers from one wireless technology to another. We support this point in the exhibit below. We note that for 2G technologies – which are now more than 20 years old – the global subscriber base is not expected to peak until this year. Additionally, the vast majority (56%) of subscribers in 2020 are expected to be 3G.

LTE spending could account for as little as 35% of mobile infrastructure spending in 2020

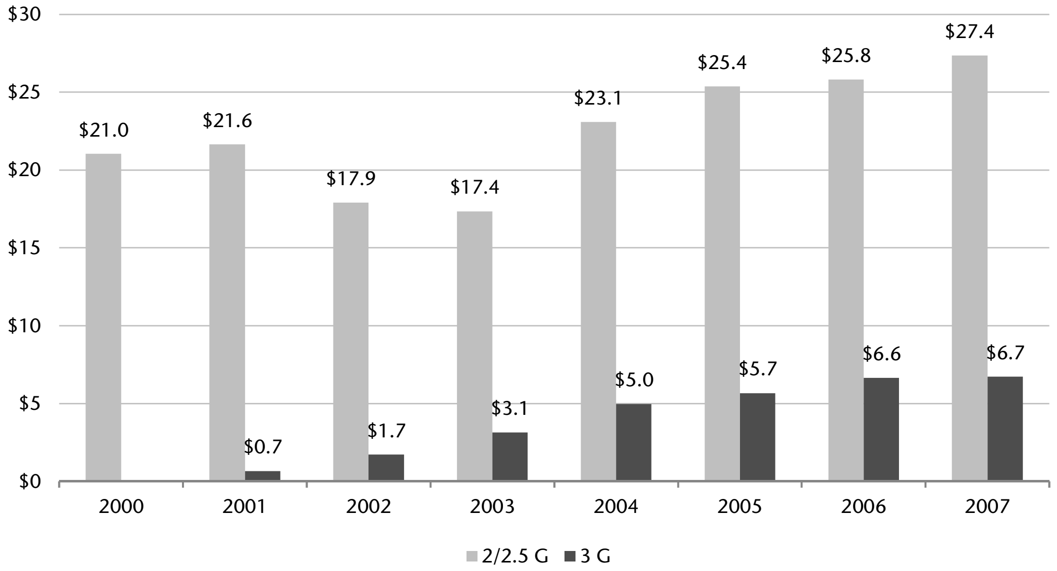
We believe that an examination of the deployment of 3G infrastructure is also potentially instructive. Here we focus on GSM-based technology as the basis of our analysis for the purpose of simplicity. As shown in the chart below, 3G deployments began in 2001. 3G network spending, however, only accounted for 20% of global wireless network spending in 2007. Projecting similar rates for 4G/LTE, we estimate that LTE spending could account for as little as 35% of mobile infrastructure spending in 2020. Keep in mind it that it will be years before developing countries begin deploying LTE.

Exhibit 68: Global Subscribers by Network Technology, 1985-2020E (in billions)



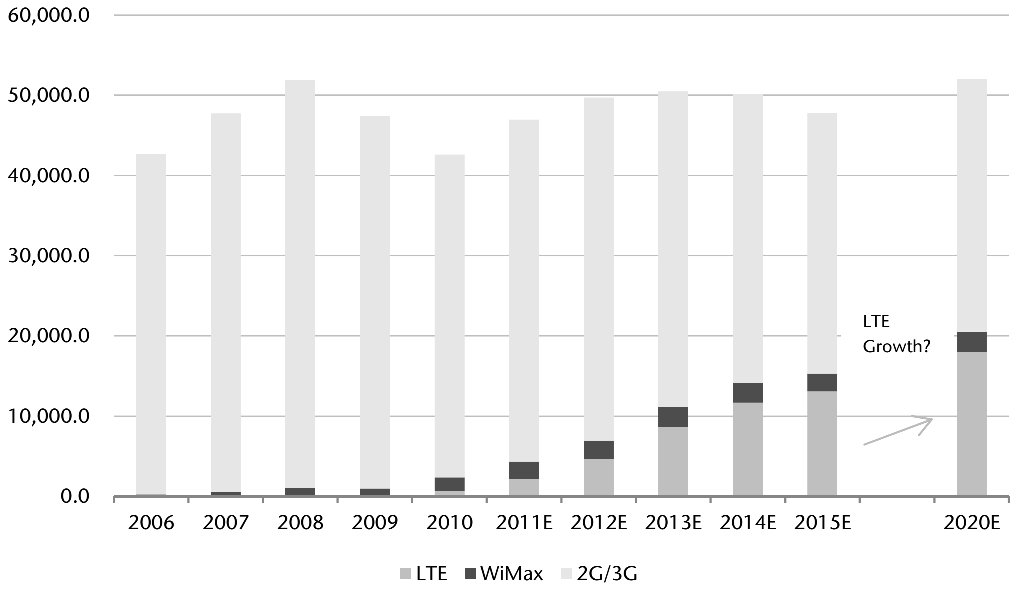
Source: CDMA Development Group.

Exhibit 69: 2G Versus 3G Spending, 2000 – 2007 ($ in billions)



Source: Dell'Oro Group.

Exhibit 70: LTE, WiMax Spending Ramp



Source: Infonetics; Jefferies & Co.

Cost Per Bit Must Drop Significantly

Of course, the increasing demand for wireless data is placing enormous amounts of pressure on operators to expand the capacity of their wireless networks. Carriers obviously cannot keep up with 92% compounded annual mobile traffic growth (through 2015) by growing their own wireless capex budgets at a similar rate. This type of capex budget growth would be disastrous for carriers' shareholders and bondholders (which are very cash flow sensitive). Moreover, carriers cannot respond to capex pressures by growing their top line (and hence, improve their capacity to spend on capex). They are pressured by their relative inability to grow revenues constrained (at least today) by "all-you-can-eat" data plans or efficiently bring new revenue opportunities to market. Separately, they will not be able to capture these rates of annual equipment price reductions from the equipment manufacturers; equipment vendors' businesses cannot support it. Hence, the carriers need to significantly reduce the cost of carrying traffic within their networks. One contact at a US RBOC mentioned to us that they are looking for 60-80% reductions in the cost per bit transported across their network. This realization is pushing operators to transition to much more efficient IP-based LTE mobile networks, and away from TDM-based 2G/3G infrastructure. We are seeing carriers with a heightened sense of urgency in making this transition. Beyond RAN infrastructure, the wireless backhaul and wireless core areas of the network need to continue to mature as well. We've laid out our views for these areas of the network below.

Big implications for backhaul networks… Working backward from the RAN, it seems obvious that the massive growth in bandwidth requirements will push the need to deploy fiber and/or broadband microwave at cell sites. For our discussion, "wireless backhaul" is the portion of the network that connects the RAN (radio base station) to the Base Station Controller (BSC) or Radio Network Controller (RNC). Separately, there is also a fixed-line connection from the BSC/RNC to the mobile packet core (EPC) that will also have to bear the impact of mobile data traffic.

AT&T expects to have roughly two-thirds of their cell sites connected via fiber by year-end

Operators are aggressively pulling fiber to cell sites in many geographies. AT&T, for example, expects to have roughly two-thirds of their cell sites connected via fiber by year-end. We see Fiber-to-the-Premise (FTTP), in particular, as a very useful technology for cost effective backhaul. For example, in urban environments where FTTP has already been deployed (the Verizon FiOS network for example), the operator should already have fiber deployed very close to where they have provisioned a small form factor radio. Here, the radio will operate as if it is another end-point on the FTTP network – just like single-family homes that might be nearby.

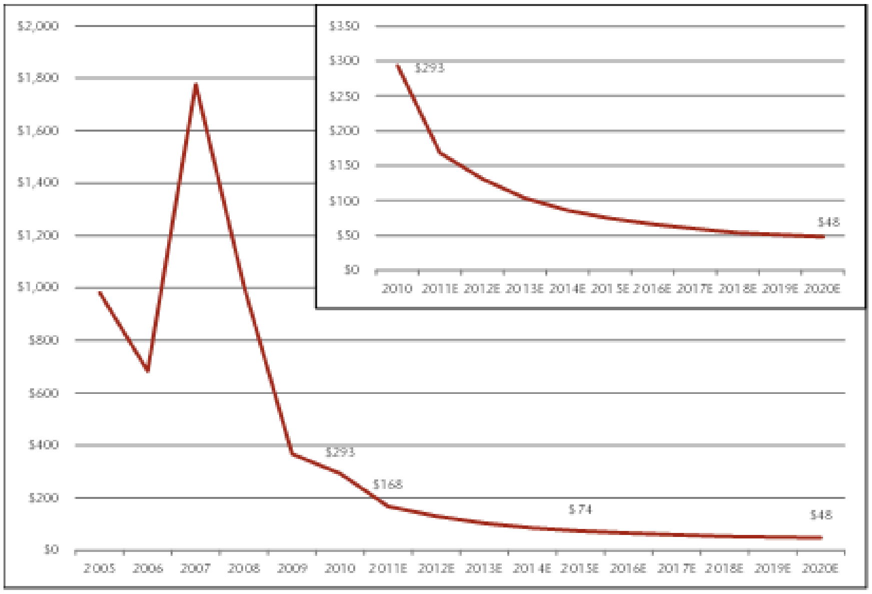
We expect the average cost per Mbps of mobile backhaul equipment capacity to drop from $168 in 2011 to $48 in 2020

Besides the sheer network traffic that needs to be backhauled, we understand that Cloud architectures will also require the backhauling of additional traffic. Alcatel-Lucent's Bell Labs organization, for example, recently calculated that, in order to perform baseband processing in the Cloud, between 1 GB and 5 GB of additional data might need to be trunked back to the data center for every 100 Mbps of subscriber data traffic. Hence, these backhaul links will be very bandwidth intensive.

Below, we graphically predict the potential path of cost-per-bit in backhaul and optical transport networks. The first chart depicts the expectation of cost per Mbps for the wireless backhaul market and the second for the entire optical equipment market. The charts combine Infonetics historical data and forecast through 2015 for the cost per Mbps with our extrapolation of these trends through 2020. Using history as our guide, we expect the rate of price declines to slow as we move toward 2020. We expect the average cost per Mbps of mobile backhaul equipment capacity to drop from $168 in 2011 to $74 in 2015 to $48 in 2020. Cost declines in mobile backhaul are due mainly to the cost advantages of deploying IP/Ethernet solutions and advances in processing capability. Similarly, we estimate the average cost per Mbps of capacity of optical equipment to drop from $0.83 in 2011 to $0.38 in 2015 to $0.14 in 2020. Note, these estimates assume that non-optical technologies faster than 100Gbps are deployed. Higher speed technologies such as 400G or even 1000G could drive further effective declines in cost per bit. The cost advantages we are modeling come chiefly from the transition to 40G and 100G speeds over time.

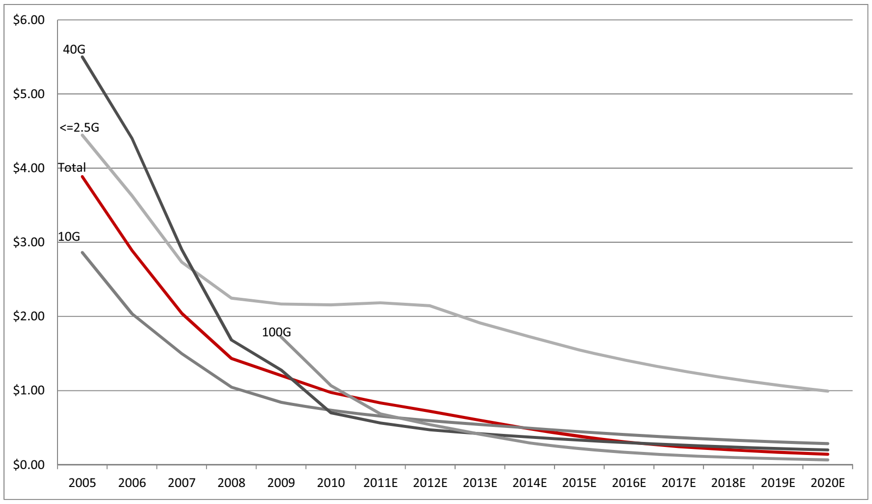
We estimate the average cost per Mbps of capacity of optical equipment to drop from $0.83 in 2011 to $0.14 in 2020

Exhibit 71: Cost per Mbps of Mobile Backhaul Equipment (2005-2020E) (Inset: 2010-2020E)



Source: Infonetics; Jefferies & Co. estimates.

Exhibit 72: Cost per Mbps of Optical Equipment (2005-2020E)

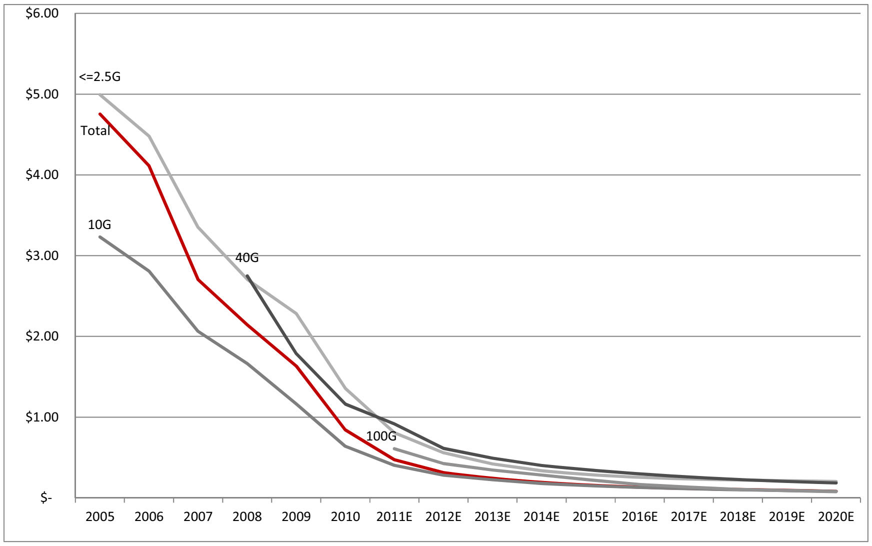


Source: Infonetics; Jefferies & Co. estimates.

We expect average cost per Mbps in Service Provider Edge Routing to drop from $0.47 in 2011 to $0.08 in 2020

Evolved Packet Core (EPC): Another Source of Cost Savings. We also expect cost reductions in the packet core as operators transition to Evolved Packet Core architectures with LTE deployment (discussed below). Existing 2G/3G mobile packet core architectures handle data in the packet-switched domain and voice in a separate circuit switched domain. With an EPC deployment, all mobile traffic (even voice) remains IP-based. Also, EPC networks will likely be deployed with fewer network components than 2G/3G networks since much of the different functions can be run on the same physical machine. Finally, many edge routing platforms that are deployed in the 2G/3G mobile packet core today can and will be repurposed (via software upgrades) for EPC functionality, provided the platforms possess the required packet processing capability to handle 4G speeds and traffic volume. These factors should reduce the number of devices required to run the packet core, driving significant cost savings. Additionally, as the chart below shows, the cost per Mbps of service provider edge routers is expected to drop significantly in price between now and 2020. This is driven primarily from advances in silicon technology allowing higher packet processing speeds and greater number of services to be deployed on one machine. As we noted earlier, an all-IP network can more efficiently process traffic. We expect average cost per Mbps in Service Provider Edge Routing to drop from $0.47 in 2011 to $0.16 in 2015 to $0.08 in 2020 (these assume no port speeds higher than 100Gbps are deployed). Infonetics expects the EPC market to grow from $100 million at the end of 2011 to $1.5 billion in 2015.

Exhibit 73: Cost per Mbps of Service Provider Edge Routing Equipment (2005-2020E)



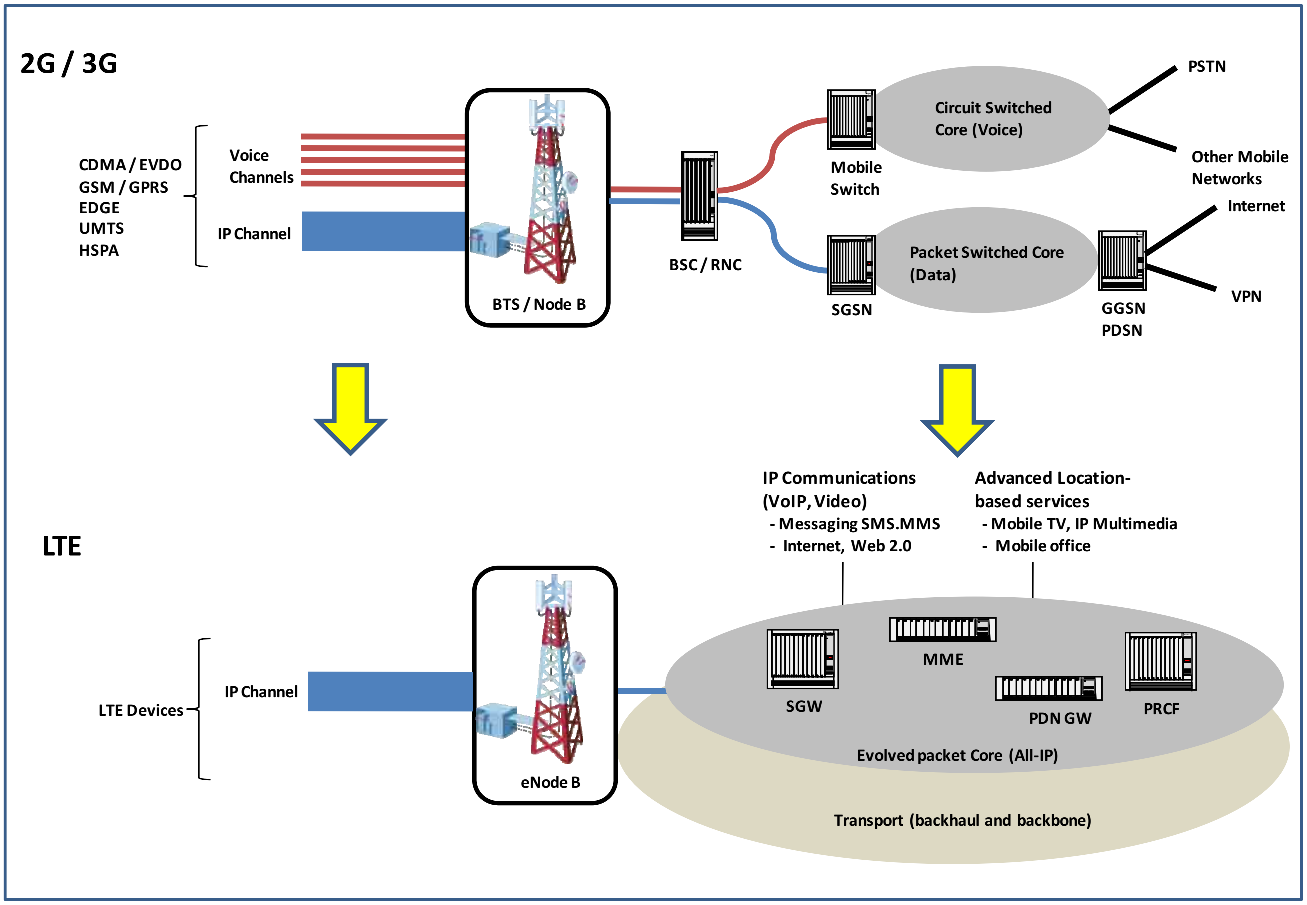
Source: Infonetics; Jefferies & Co. estimates

Mobile Core Networks Must Evolve... Into EPC

As highlighted above, wireless data is causing significant pain points for mobile operators. Traditional TDM/circuit-based networks which have historically been at the core of wireless networks were not designed to handle this type of volume. To address the issue, the industry is: 1) rapidly evolving IP-based mobile core networks; and 2) pursuing mobile data offload techniques (as discussed). Before explaining the significant changes LTE/4G deployment will have on the packet core piece of the network, we will discuss the reasons that the existing mobile packet core architecture will not work in a LTE/4G environment.

The 2G/3G Mobile Network Core Isn't Suited for 4G. Evolved Packet Core developed out of the inability of traditional mobile packet core networks to support LTE. As the chart below illustrates, the core network behind 2G/3G wireless infrastructure parses out the voice and data traffic into separate traffic paths. For the voice traffic, carriers historically deployed monolithic, TDM-based, circuit switches to manage the set-up and tear-down of voice calls. The 3G data traffic is divided out separately into a network path where it flows through a SGSN (Serving GPRS Support Node). The SGSN connects to the Base Station Controller and handles the mobility management and authentication of the wireless data users. Also, the SGSN performs protocol conversion and compression between the wireless side of the network and the core IP backbone. The Gateway GPRS Support Node (GGSN) sits deeper in the network. It is effectively a router that routes mobile-originated traffic into the correct network. For data traffic coming into the mobile network from external networks, the GGSN will keep track of where the destination mobile subscriber is located and route the inbound traffic to the appropriate SGSN. Finally, the GGSN is hooked into the wireless operator's billing system in order to help maintain billing records for data usage. This model has been used very successfully for 2G and 3G network deployments. Vendors like Starent (now part of Cisco), NSN, and Ericsson (via their Juniper relationship) have had significant success in this market. In 2010, the market for 2G/3G mobile packet core infrastructure was approximately $2.9 billion, according to Infonetics (this figure includes PDSN gear for CDMA packet core environments).

Exhibit 74: Migration to Evolved Packet Core



Source: Alcatel-Lucent; Jefferies & Co.

Looking ahead to LTE, this model has to change for a variety of reasons:

- **The EPC must scale massively…** LTE is spectrally more efficient and therefore scales up to much higher bit rates than traditional 3G RAN technologies. Moreover, the sheer amount of data traffic hitting 4G mobile devices should grow massively as subscribers adopt increasingly data-intensive applications. As such, many traditional SGSN and GGSN equipment platforms will run out of capacity.

- **Must Scale in Different Dimensions…** Under LTE, the network elements will have to scale in different dimensions independently – by number of subscribers, number of sessions and types of application. Currently, the SGSN and GGSN have both data plane and control plane functionality, making it difficult to scale these different dimensions independently. With LTE, the number of subscribers is expected to grow rapidly. This is mostly a processing power (data plane) issue. At the same time, complex, media-rich applications and new business models (i.e., data caps, tiered and time of use pricing) will require beefed up policy and billing management requirements. Therefore, the control plane must scale at the same time as the data plane. However, the number of subscribers, sessions and applications supported by a network often grow at very different rates. The current architecture requires the control and data planes to scale at the same time. This is inefficient and inflexible.

- **Require End-to-End QoS…** Quality of service (QoS) becomes critically important in these new network deployments. Traditional SGSN/GGSN mobile packet cores were designed for low-speed, best efforts packet transport. Now, voice traffic (and more and more rich media applications) is traversing these IP networks, and carriers have to ensure "five 9s" reliability and superior quality of service – not possible via existing 2G / 3G network cores.

A Primer on the Evolved Packet Core

Evolved Packet Core is a new all-IP network architecture originally designed for LTE networks. The specification was outlined by the Release 8 3GPP standard which was finalized in 1Q09. Looking forward, the EPC specification takes the functions of SGSN and GGSN gear and parses them out into separate functions – a data plane and a control plane – for added reliability and scalability. The data plane (i.e., where subscriber data traffic passes through hardware platforms) includes two devices – the Serving Gateway (SGW) and the Packet Data Network Gateway (PDN GW). The network diagram above illustrates a traditional mobile packet core network and its evolution to the Evolved Packet Core architecture.

The SGW is used to route traffic between wireless subscribers and the PDN GW. Specifically, the SGW manages handoffs/wireless connections as users move between eNodeBs as well as interconnection with other 2G/3G networks. Data traffic destined for the Internet and/or other packet data networks is passed back to the PDN GW deeper in the network. The SGW is also used to replicate local traffic for lawful intercept requirements.

The PDN GW routes data between/among SGWs and all of the disparate IP networks the wireless provider interconnects with (the public Internet, other operators' IP networks, etc.). Also, the PDN GW supports: 1) carrier-specific policies like usage and resource allocation for specific customer/traffic flows; and 2) packet-filtering/deep packet inspection of user traffic.

The two other components of the Evolved Packet Core architecture are MME (Mobility Management Entity) and the Policy and Charging Rules Function (PCRF). Both of these functions reside in the control plane of the network – typically as software residing on industry-standard ATCA servers. The MME is used to handle set-up and tear-down of sessions between subscribers and the mobile network core. It performs: 1) signaling and session management; 2) management of mobility states (tracking of idle devices, etc.); 3) authentication of subscribers via a HSS server; and 4) selection of legacy gateways for interfacing with 2G/3G networks. The PCRF is a software function that manages policy information to and from the network for operational support systems and other back-end systems. It allows the creation of network rules and allows for enforcement of those rules on the network.

Looking forward, we expect that the EPC market to become large over time. As stated earlier, mobile packet core infrastructure is currently a $2.9 billion market annually. 4G/EPC infrastructure is a tiny sliver of that market right now. Over time, we expect that 4G network growth will drive operators from traditional 2G/3G packet cores to EPC infrastructure. Initially, EPC equipment will remain a small piece of the market (Infonetics forecasts it to be a $100 million market in 2011) and, over time, usurp all of the mobile packet core market. Given the pure amount of wireless traffic growth expected, the EPC market is likely to be bigger than the 2G/3G packet market is today.

By 2020, we expect EPC devices to dominate the packet core market. Vendors like Cisco, Ericsson and Huawei must have success in the migration to EPC

The Stakes Are High for Incumbents… Looking at the evolution of mobile packet core networks, it becomes obvious that the stakes are quite high for the established vendors in this market – Cisco/Starent, NSN, Ericsson/Juniper, Alcatel-Lucent and Huawei which collectively own the market for 2G/3G mobile packet cores. As carriers deploy LTE and transition their network cores to EPC, we expect them to initially deploy EPC elements in centralized network locations. As LTE subs and traffic grows over time, they will move to a more distributed architecture where the SGW and PDN GW elements sit closer to the network edge and the MME/PRCF elements remain centralized in the network. Over time, 2G/3G packet core traffic will get folded onto this Evolved Packet Core and investments in traditional SGSN/GGSN/PDSN equipment will trail off. By 2020, we would expect EPC devices to dominate the packet core market. As such, we believe vendors like Cisco, Ericsson (and Juniper via the MX partnership), and Huawei must have success in winning EPC. For vendors like Alcatel-Lucent which haven't traditionally had much 2G/3G mobile packet core business, the EPC opportunity is upside.

Cache Will Be King

Related to the EPC discussion above, "caching" of popular video content will become an increasingly important tool for carriers in reducing mobile network congestion. Caching is loosely defined as the storage of content in a location that is relatively closer to the subscriber or the edge of a network to avoid transporting that content repetitively from a more centralized source. This can save network bandwidth behind the point of caching and also potentially improve the speed with which content is delivered.

Caching is already an important issue in wireline networks as service providers increasingly migrate from a broadcast/multi-cast model to a personalized/unicast /on-demand model. In a broadcast model – when popular content is watched by all members of a potential viewing audience at the same moment – caching has little benefit. Data travels in a single stream from a centralized source and is then replicated at another point in the network and sent to all subscribers at once. However, when subscribers are given the flexibility to watch content at a time of their choosing, a unique stream is created for each viewer. If content is popular, carrier networks can become overburdened sending the same content repetitively from a centralized location. Caching is a tool already widely utilized by Content Delivery Networks (CDNs), but our discussions with industry contacts suggest there is a desire to move caching from behind network peering points to Edge Routers. As the cost (and physical footprint) of storage has decreased significantly over time, the business case for adding storage capabilities to these network devices is made more attractive.

New caching solutions are emerging to save capacity both in the mobile core and potentially in the RAN

Our discussions with industry contacts suggest that, as video continues to proliferate on wireless networks, new caching solutions are emerging to save capacity both in the mobile core and potentially in the RAN. We are hearing that carriers are particularly keen on saving on mobile core capacity as it commands a roughly 30% premium to Edge Router capacity simply because it "speaks" the protocols of mobile networks, and that potentially 70-80% of the total cost of network transport can be saved for the content that is cached. We understand solutions are being developed to cache content in front of the mobile core, perhaps near the base station or next to the RNC. Another industry contact suggested that carriers may consider caching some content in mobile devices, and carriers may even choose to wait until a Wi-Fi connection is available to push that content. Clearly there is an optimization exercise for carriers to perform here that trades off the popularity of content, the cost of storage, and the cost of network capacity in determining what content to cache and where. We also expect caching to be increasingly tailored to local preferences.

Policy and Subscriber Data Management: Pipes Have to Get Smarter

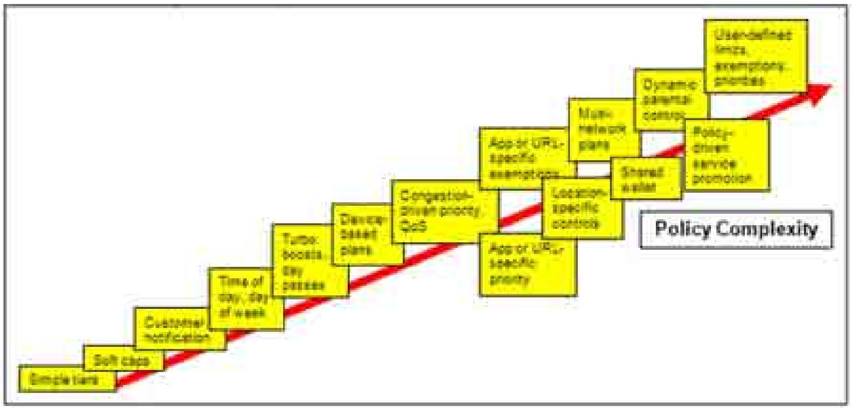
While we expect wireless bandwidth capacity to dramatically increase in the coming decade, we expect wireless bandwidth to remain a scarce resource. History suggests that applications invariably emerge to consume all new available bandwidth on operator networks. We believe that the rise in connections due to new subscribers, substantial growth in machine to machine connections, and a proliferation of new applications that use network bandwidth will drive the need for significantly more complex set of policy tools to dynamically manage bandwidth consumption, develop new operator business models, and enable new services.

The rise in connections due to new subscribers, substantial growth in machine to machine connections, and a proliferation of new applications that use network bandwidth will drive the need for significantly more complex set of policy tools to dynamically manage bandwidth

From a definitional standpoint, Policy Management consists of software that uses pre-set criteria and rules to govern subscriber access to network resources or applications. For example, the Policy Management function could determine whether a wireless subscriber has the appropriate entitlements to access a video based on: 1) their subscription plan; 2) their bandwidth usage to date within a billing period; 3) current level of network congestion; 4) the time of day; 5) the type of network the user is on (2G, 3G, or 4G); 6) the nature of the transaction; 7) the quality of service; and/or 8) the URL being accessed. To date, Policy tools have been relatively blunt and largely consisted of "fair use" enforcement – i.e., specific user bandwidth is managed during times of congestion.

Policy has also been applied at the application level (throttling peer-to-peer traffic is a commonly cited use case).

Exhibit 75: The Route to Policy Complexity


Simple tiers
Soft caps
Customer notification
Time of day, day of week
Turbo boosts, day passes
Device-based plans
Congestion-driven priority, QoS
App or URL-specific exemptions
App or URL-specific priority
Multi-network plans
Location-specific controls
Dynamic parental control
Shared wallet
User-defined limits, exemptions, priorities
Policy-driven service promotion
Policy Complexity

Source: Heavy Reading.

Going forward, however, Policy Management offers the potential for carriers to personalize services to a far greater degree. For example, a carrier could offer improved Quality of Service (QoS) for a given application or provide differentiated service for users who have paid for higher QoS. Operators also could use these tools to push users onto Wi-Fi networks as a traffic offload solution.

Policy Management will also act as the key control point for enforcement, communicating with and coordinating network elements required to enforce policy. In an IMS network, this function is provided with the Policy and Charging Rules Function (PCRF); however, the limited deployments of IMS to date have not stopped operators from deploying more advanced policy functions in their networks.

Subscriber Data Management (SDM) will Rise in Importance. Implicit in the collective need for operators to implement new Policy capabilities is the corresponding need for richer subscriber data. Further, this data must be made more readily available to network elements responsible for enforcing Policy. Currently, much of the subscriber information necessary for advanced policy functions is not centralized and readily available to all network elements. In many cases, subscriber information is also siloed by device. Long-term, it makes sense that each user will have a single "profile" that crosses all their devices. This will be necessary not just for operational simplicity but in some cases also to meet regulatory requirements such as "bill shock" regulations that require consumers be notified prior to crossing certain bill quantity thresholds. Additionally, rich subscriber information can serve important diagnostic purposes. For example, when a problem arises in the network, information on the device, type of network, application in use, whether the user was roaming/not roaming, etc. are all potentially very helpful information in network management and will allow carriers to be more proactive in addressing network issues as they arise.

Policy and SDM Will Enable New Revenue Opportunities. Our discussions with industry contacts suggest that the initial motivation for the implementation of new Policy tools is cost savings – i.e., operators save both capital expenditures and operating expenses by running networks more efficiently. However, as noted in the discussion above, sophisticated Policy tools also offer the potential for new revenue opportunities. Simple examples include more granular speed tiering, "turbo" boost options, or perhaps charging based on time of day (data usage at peak hours becomes more expensive). Location-based or event-based advertising, in our opinion, is likely to gain traction as SDM capabilities become more robust. Application-level parental control is another potential use case. Parents, for example, could prohibit use of Facebook applications during school hours or potentially block communications from other users.

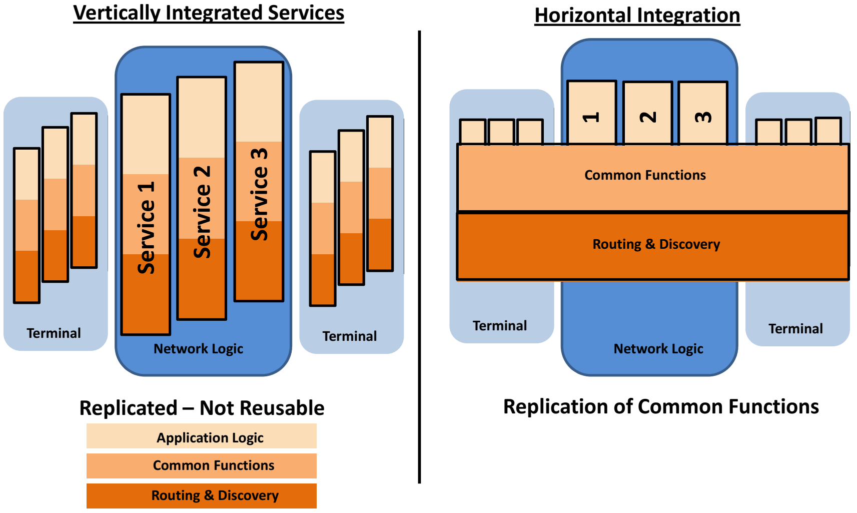
Potential Barriers to More Sophisticated Policy Management. While the concept of using Policy to offer differentiated services to improve ARPU likely sounds compelling to service providers, there are a number of issues that could inhibit broad adoption. It remains to be seen whether Policy Servers can scale to accommodate the myriad transactions and sessions generated by subscribers. The integration of billing functions into Policy is also not a trivial task, nor is linking all the relevant subscriber data in real time. Finally, it is worth noting that Policy Management has resided almost exclusively in the domain of network managers. To achieve the vision described above, Policy must be shaped with contributions from marketing and product development. Historically, it has been difficult for carriers to compel different departments within Network Engineering to collaborate and cross-department collaboration will likely prove even more challenging. Nonetheless, as carriers continue to struggle to grow revenue as network costs rise, we expect carriers to experiment with new business models to avoid the "dumb pipe" phenomenon that carriers have feared over the years. This will require that Policy and SDM technologies get embedded in the network.

IMS and Convergence – At Last

We believe that by 2020, carriers will have largely completed the transition to IMS, or IP Multimedia Subsystem, on the wireless sides of their networks. This architecture has been very slow to deploy since the standards were originally crafted several years ago. Factors behind the slow adoption of IMS include: 1) the sheer complexity of the architecture; 2) lagging network migration from TDM to IP; 3) lack of true interworking between vendors, which creates vendor "lock-in" for operators; and 4) sheer inertia among large telecom service providers. Nonetheless, we believe that IMS or IMS-like network designs will become a necessary part of telecoms networks by 2020. Below, we have outlined the key aspects of IMS and the associated benefit for carriers in a new world driven by mobile data.

At its most basic level, IMS enables convergence of Fixed and Mobile networks by defining a network architecture, or framework, for carriers. The framework allows subscribers to access the same features, applications, and content regardless of how they are connected to the network (fixed, wireless, or otherwise). Historically, the applications that run on them) have been siloed. Within an IMS environment, for example, a subscriber could access their personal voicemail via a wireless phone or a traditional landline connection. Today, the subscriber has separate voicemail systems for each of their phones. In another example, we note that features like Presence can only be enabled in a PC environment right now. With IMS, Presence could be used upon a myriad of subscribers' network-connected (and IP-based) endpoints – whether a work PC, home PC, wireless handset, or wireline handset, etc. The chart below illustrates one of the key concepts behind IMS.

Exhibit 76: The Concept of IMS



Source: Ericsson.

The IMS specification was originally designed by the 3GPP standards body as an approach for providing "Internet Services" over GSM/GPRS-based wireless connections. Later, the standards effort was broadened to include a host of standards bodies (ETSI/TISPAN) for wireless and wireline networks.

Within the IMS framework, all services —including voice — will have migrated from TDM- and circuit-based networks to IP. Within these IP-based environments, operators will use the Session Initiation Protocol, or SIP, to set up and tear down IP-based sessions. Further, IMS enables a variety of services – including voice, video, or text – to be delivered using SIP. Similarly, the Diameter protocol will be used to access network-based databases for Policy and Subscriber Management. These network functions provide for "AAA" (Authentication, Authorization, and Accounting) of subscribers. Further, the Diameter protocol and Policy data is used enforce various policy/traffic rules on the network.

The transition to IP for voice is a relatively dramatic departure from both fixed and mobile networks today. In 3G mobile networks, the core infrastructure for voice is circuit-based. At this point, even in LTE networks, voice is still carried on the 3G portion of the network, as "Voice over LTE" technology remains in the nascent stages (in February, Verizon declared it had made the first voice call over a commercial LTE network using the Voice-over-LTE (VoLTE) standard). We discuss these network functions in greater detail below.

IMS also enables new services and capabilities (and revenue opportunities). In addition to enabling simpler, converged networks, IMS offers carriers the capability to offer new value added services that could not be cost-effectively provided under legacy architecture. Classic examples include video telephony, "push-to-talk" capability, chat and other "presence-aware" services, and multimedia content sharing during a voice call. We expect these types of advanced services to become ubiquitous by 2020, and that handsets will not be the only devices delivering such services. Importantly, these new value-added services could represent new revenue opportunities. IMS allows carriers to more easily differentiate between different means of communication and content and also enables the ability to bill for these different services.

IMS Helps Reduce Network Costs. Finally, we see IMS as a critical piece of network architecture in 2020 as it allows operators to significantly reduce their opex and capex. As the chart below illustrates, the technology lets operators leverage the cost of network functions like routing, policy, subscriber management, and application servers across a wide variety of service offerings. Operators can finally create a service offering once, and leverage it across all of their customers – regardless of how those subscribers are attached to the network.

Well-Positioned Companies: Mobile Infrastructure

Below, we've highlighted a number of vendors within our research universe that are poised to most significantly benefit from this pending transformation in wireless network designs by 2020.

Alcatel-Lucent. We believe Alcatel-Lucent's leadership in wireless infrastructure positions the company well for the remarkable increase in mobile data traffic in 2020. Driven by the emergence of LTE in the US, the organization now has a 30% market share in LTE infrastructure – that's versus roughly 14% in the WCDMA cycle. Furthermore, we like the approach Alcatel-Lucent is taking to help carriers find compact, power-efficient ways to expand wireless network coverage. With their new lightRadio product, the organization is clearly ahead on the development of small form factor solutions and a thought-leader in the space. Of course, Alcatel-Lucent also stands to benefit in other areas of their portfolio. The company's IP Division, for example, is working to sell the 7750 Edge Routing platform into Evolved Packet Core applications. The system, with its huge scale and ability to support hundreds of thousands of unique subscriber sessions, is well positioned here, in our view. Separately, the organization has very strong FTTP/access (12% global market share in 2Q11 per Infonetics) and Optical Transport product portfolios (18% global market share in 2Q11 per Infonetics). Finally, the organization has many parts of a larger, overall solution for operators. To the extent that operators make end-to-end network buying decisions, Alcatel-Lucent should benefit.

Broadsoft. The transition to 4G/LTE wireless networks will be a significant potential catalyst for the company. Broadsoft is a play on the transition from existing TDM-based to IP-based infrastructure. As more and more network end-points (i.e., PCs, landline phones, wireless phones, other devices) become IP-enabled, Broadsoft's market opportunity expands. At this point, less than 5% of network end-points are IP-based. Recall that 4G devices are 100% IP-based, whereas 3G/2G technologies run on circuit-switched and/or ATM networks. Initially, most 4G networks will carry only data traffic, with 4G voice capability coming later (in the 2013 time frame). Broadsoft, in theory, could collect a small seat license fee for each 4G handset sold as carriers run wireless voice applications off of Broadsoft's Broadworks platform. While the license fee would be small (our guess is

<$1), several billion 4G/LTE phones may get implemented in the network over the long term.

Juniper. Juniper is another fairly pure play on the transformation from TDM to IP-based networks. With a 100x increase in mobile data traffic anticipated through 2020, in our view, Juniper stands to benefit from the increased traffic load within their Edge and Core Routing businesses. Moreover, the company's Security technology expertise is highly leveragable in the wireless space.

Tekelec. In our opinion, Tekelec's extensive expertise in signaling protocols and network performance intelligence position the company very well for empowering the intelligent network of the future. We also believe that Tekelec's assertion that Policy and SDM functions should be centralized makes sense given the need for the Policy Engine to have an "end-to-end" view of the network to perform optimization that is truly "global" from a network perspective. Intuitively, it also makes sense to us that Policy/SDM functions should be found in a specialized device given the intelligence needed for these functions. This contrasts with the desire of some vendors to embed Policy functions in network devices such as GGSNs. Our concern is that embedding these functions in another network device is likely to be suboptimal as it could detract from the core function of that network element, and in many cases the network element in which the Policy function might be embedded might not have visibility to the whole network. While the company is fighting through significant near-term product transition issues, we see Tekelec as well positioned with its Next Gen products longer term.

ZTE Corp. We see ZTE Corp. as a winning stock for the long term in telecommunications infrastructure, and is a proxy for capturing much of the structural growth we anticipate in Asia.

The Underlying Semiconductor Content of Emerging Mobile Infrastructure

We expect a dramatically higher level of mobility in 2020 to drive semiconductor growth across three broad classes of end markets: Mobile Terminals, the Cloud/Data Center, and the Communications Infrastructure that connects those two end points of the network.

Nearly 8 Billion Mobile Devices Generating 100x More Traffic

The demands placed on semiconductors in 2020 will be staggering, but the opportunity will be both compelling and far reaching. The requirement for semis at the mobile terminal is obvious – process voice/data/video signals faster, cheaper, and more efficiently than before. Perhaps not as obvious is the requirement in the cloud – i.e., more servers to serve up applications to those mobile devices – and from the network connecting the terminal to the cloud.

The 100x+ increase we forecast in wireless traffic will stress the network at multiple points, which will cause a shift the network architecture. At the edge of the network, the number of cell site deployments will explode, but will become smaller both physically and in range. At the access point and core of the network, data transmission speeds will need to become more efficient, increase in speeds, but evolve more to packet-based topologies.

Terminal, Cloud and the Interconnection Between the Two

We see three areas of opportunities for semiconductors: 1) at the mobile terminal, which includes smartphones, tablets, notebooks and ultrabooks, 2) in the data center/cloud, which includes servers and data center switching and routing equipment, and 3) in the communications infrastructure in between the two. To enable anticipated demand, semis will have to do what they have done for the past 30 years: Become smaller, cheaper and more efficient. We believe that there are two classes of semiconductor winners in this environment:

- Chip Integrators, the companies that drive system costs down by integrating multiple functionalities onto a single chip. This group of companies will typically have multiple technologies as well as the capability to integrate them together onto a single chip. Often, their technology will include the CPU (or the “brains”) of the mobile terminal, a critical element and often the first component decision a mobile terminal OEM will make. CPU and FPGA providers will fall into this bucket.
- Superior Point Solutions Providers, the companies with a unique technical capability, for example, the ability to transmit data at a much higher rate. Analog companies typically fall into this bucket.

We highlight some of the expected beneficiaries of each area in the table below.

Exhibit 77: Semiconductor Beneficiaries Increased Mobility

	Mobile Terminal	**Infrastructure that Connects Terminals to the Cloud**	**Cloud/Data Center**
	Smartphone, Tablet, Notebook, Ultra-books	Routers, Switches, Base Station, Radio Head, Backhaul, Transmission, Optical Modules	Server, Storage, Routers, Switches, Optical Modules
CPU/FPGA, SoC	ARM, NVDA, BRCM, MRVL, TXN, QCOM, INTC, Mediatek, ST-Ericsson	BRCM, NETL, CAVM, PMCS, EZCH, ALTR, XLNX, LSCC	INTC, AMD, NETL, CAVM, EZCH, PMCS
Connectivity	BRCM, MRVL, QCOM, TXN, STM, NXPI	IPHI, PMCS, AVGO	IPHI, NETL, AVGO
Analog/PLD	Murata, AVGO, MXIM, TXN, ADI, BCDS, LSCC	ADI, LLTC, MXIM, TXN, BCDS, LSCC	ADI, LLTC, MXIM, TXN, LSCC

Source: Jefferies & Co.

Top Mobility 2020 Semiconductor Picks

Mobile Terminal Picks: BRCM, AVGO and Murata

In both handsets and communications infrastructure, Broadcom has both access to a broad range of communications technology, as well as the capability to integrate those technologies into a single chip, thereby driving efficiencies and enabling mass market deployment. The company's combination connectivity products (e.g., WiFi/Bluetooth/GPS/LTE), and future application processor products should drive growth in the smartphone and tablet markets.

Both Avago and Murata have improving capabilities in the Radio Frequency and analog portion of the mobile terminal market in filters, power-amps and front-end-modules. Avago's F-Bar filter increases its penetration of smartphone and tablets in multiple types of wireless networks. Murata has been a leader in the development of wireless technologies and is capable of supplying SAW filters, SAW duplexers, antenna switch modules, LC filters, and WiFi modules for RF circuits, which will allow the company to benefit from market expansion of LTE mobile equipment, in our opinion. Murata offers several key components of FEMs, such as antenna switches, LC filters, SAW filters and SAW duplexers, and the company is very strong in module products thanks to its LTCC (Low Temperature Co-fired Ceramics) technology, which allows for the miniaturization of modules due to multi-layering of the circuit and also to the reduction in the number of mounted components. As a result, the company has high market share in ASMs, RX modules and FEMiDs. Murata has also announced the acquisition of Renesas Electronics' PA business; PAs are key components for TX modules, and the acquisition is anticipated to provide Murata with the ability to support all types of FEMs and provide customers with optimal solutions in RF circuits.

Communications Infrastructure Picks: ALTR, IPHI and NETL

With FPGAs (field-programmable gate arrays) now being introduced with DSP (digital signal processing) and CPU cores, as well as with high speed I/O capabilities, companies like ALTR and XLNX also look like companies with System-on-Chip (SoC) capabilities. We expect IPHI's high speed analog design capability to benefit both in the data center and in the core transmission network. We expect NETL to benefit from its expertise in next generation network processing and wireless infrastructure.

Data Center/Cloud Picks: INTC, AMD and PMCS

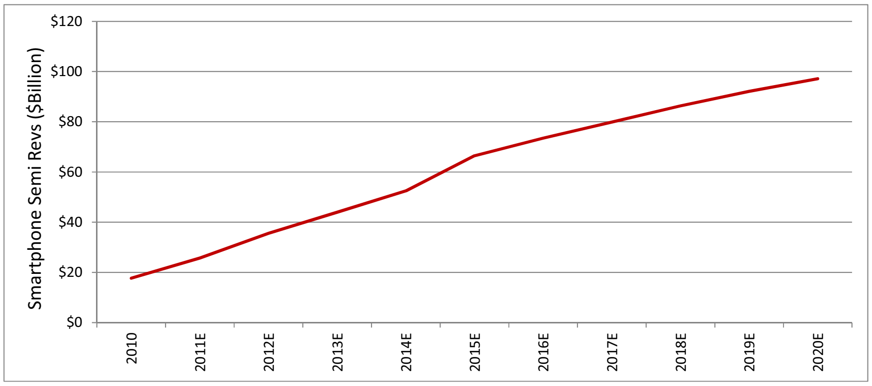
Intel's Server MPU business is already delivering double-digit revenue growth, and we expect Intel to increase its share of the multi-core processor market for routing/switching over time. We could become more constructive on INTC with visibility into Smartphone and/or Tablet market traction for its low-power MPU/SoC. AMD is hitting a server product cycle with its Bulldozer Platform. PMC-Sierra has 65% revenue exposure to the data center, and is ramping its SAS2 (6Gig) product cycle.

1) Mobile Terminals

Based on Jefferies' long-term forecast of smartphone growth, and semiconductor content in the iPhone as a proxy for all smartphones, we estimate the smartphone semiconductor market to approach $100 billion in 2020.

We estimate the semiconductor market for smartphones will approach $100 billion in 2020

Exhibit 78: The Semiconductor Market for Smartphones



Source: IDC; Jefferies & Co. estimates.

Exhibit 79: Semiconductor Market Growth, 2010 to 2020E

	2010			2020E		
(million)	Units	$ content	Revs	Units	$ content	Revs
Smartphone CPU	299	$11	$3,287	2455	$5	$12,275
Smartphone Non-CPU	299	$48	$14,352	2455	$34	$83,467
Tablet	18	$11	$198	595	$6	$3,511
Notebook (ex Netbook)	176	$92	$16,201	328	$50	$16,236
Server	9	$1,002	$8,918	18	$906	$15,949

Source: Mercury; Gartner Research; IDC; Jefferies & Co. estimates.

Mobile MPUs

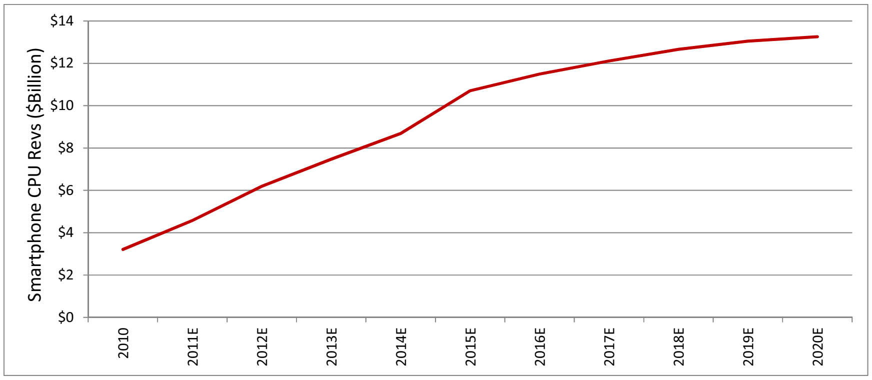
We think Intel is likely to see an expanding market for its low-power x86 MPU roadmap in smartphone as early as 2012

Smartphone capabilities shifting toward Tablet/Notebook. We expect the growing complexity of multi-tasking applications and usage models to drive smartphone compute capabilities increasingly toward tablet/notebook. Consequently, we think PC microprocessor provider Intel is likely to see an expanding market for its low-power x86 MPU roadmap in smartphone, potentially starting as early as 2012. We expect ARM-based MPUs maintain their dominant share of the smartphone application processor market for the foreseeable future, but also note that if Intel is able to penetrate the market through at least one tier-1 OEM over the next 6-to-12 months, it would significantly increase Intel's chances of taking market share from ARM-based MPUs faster than investors might be expecting.

We estimate smartphone CPU ASP decline of 5% to 8% per year

We see a longer term threat to ARM-based MPU's dominant market share position in smartphone, from Intel's x86 MPU

Exhibit 80: Smartphone CPUs (Application Processor)



Source: IDC; Jefferies & Co. estimates.

MPU market shifting toward Smartphone. Historically, PCs have been the largest market for microprocessors, dominated by INTC (~85% share), and AMD (~15% share). In 2020, we expect smartphone and tablet MPU to dwarf the PC MPU market by a factor of ~3x, given the significantly faster growth forecast for smartphone/tablet relative to PC.

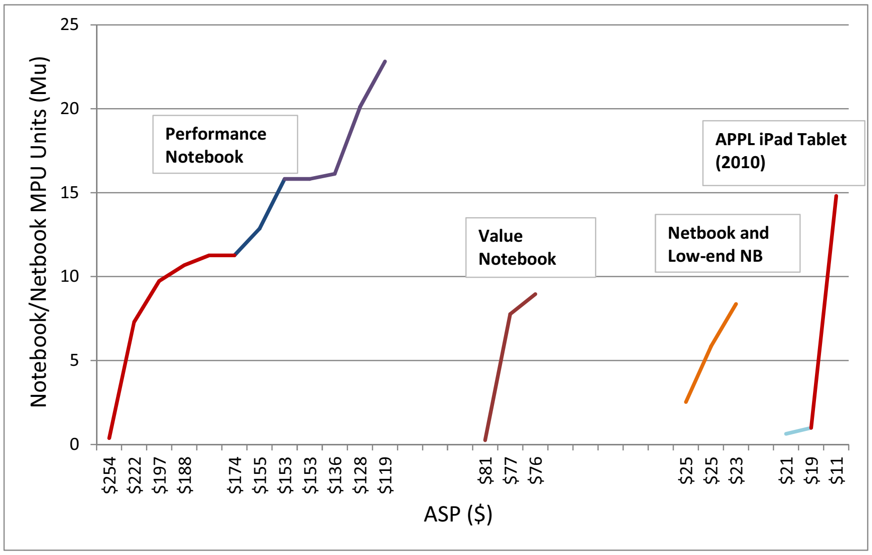
Our analysis suggests the MPU market is elastic at lower price points

The MPU market is elastic at lower price points. Our analysis suggests PC MPU demand is elastic (elasticity > 1) at lower notebook MPU price points, which we believe has helped drive revenue growth for INTC and AMD, as they descended the MPU price curve over the last five years. Intel most recently experimented with the Netbook category, which was one of the fastest growing categories until it ceded growth to the iPad.

Historically, INTC/AMD enjoyed a strong higher-end PC MPU market, which motivated them to limit lower-end MPU offerings, except as needed to compete with each other

Going forward, we think Intel/AMD will need to introduce lower power, lower priced MPU at a faster pace, to capture mobile opportunities

Exhibit 81: The MPU Market Is Elastic



Source: Company reports; Mercury; Jefferies & Co. estimates.
Note: X-axis not to scale.

Intel/AMD need lower power, lower cost MPUs to capture share of Smartphone/Tablet. Going forward, we believe that Intel (and AMD) needs to introduce lower-power processors at lower price points at a faster pace than it did over the last decade. We think this could occur through the ultrabook, tablet, and smartphone categories of devices, which could drive the next phase of growth for Intel. Intel's industry-leading manufacturing prowess, low-power Atom-based SoC roadmap, and vast software development/enabling resources position it well for the shift in its market, in our view. However, we think there is risk that Intel/AMD may not adopt necessary cultural changes quickly enough to find the right customers and partners to address the growing mobile market at lower price points, putting them at risk of low-end disruption at an accelerating pace by ARM-based MPUs.

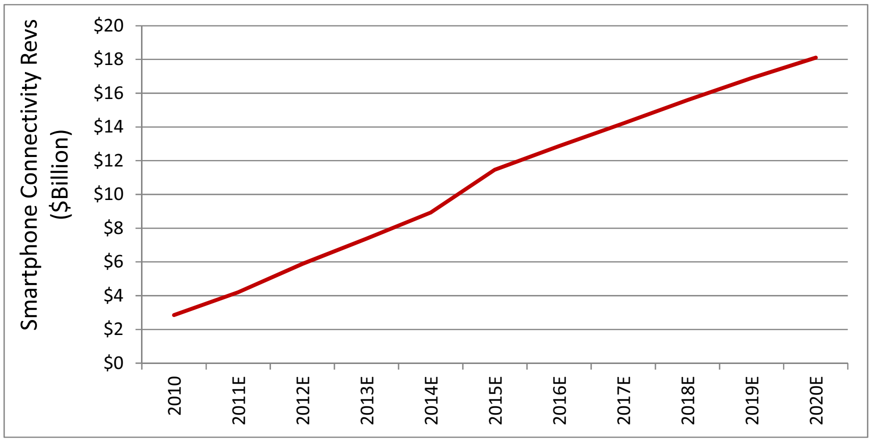
Mobile Connectivity

We estimate the Smartphone Connectivity market will grow to $18 billion in 2020

We assume a blended ASP decline of ~3% per year

We estimate the Smartphone Connectivity market will grow to $18 billion in 2020, driven by increased demands to connect mobile terminals to the network. We expect BRCM, QCOM and MRVL to be beneficiaries of continued growth in Smartphones, based in large part on their connectivity portfolios which include Bluetooth, WiFi, and GPS, as well as their ability to integrate these functionalities into single chip solutions at price points suitable for mass market deployments.

Exhibit 82: The Smartphone Connectivity Market (2G/3G/LTE Baseband, WiFi, Bluetooth) ($ in billions)



Source: IDC; Jefferies & Co. estimates.

Analog and Radio Components in LTE Terminals

Multi-frequency bands will be a key

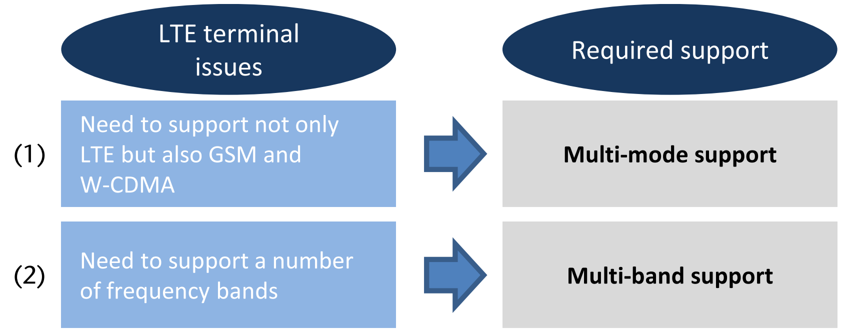
As we have described, consumers are not satisfied with the current speed of wireless communication when they use applications on the mobile internet, in our view. We think that end-users' requirements for faster Internet access speeds will increase as they require better functionality for mobile applications and devices.

We have outlined our belief that LTE (Long Term Evolution) will take off and serve as the next generation of wireless communication standard in order to meet consumers' needs. We think that the following two changes will occur, which will have a substantial impact on wireless equipment as well as electronic components, especially high-frequency components (see the chart below).

(1) Need to support not only "LTE", but also "GSM" and "W-CDMA" (multi-mode functionality); and

(2) Need to support multi-frequency bands.

Exhibit 83: LTE Will Require Multi-Mode and Multi-Bands Functionality


LTE terminal issues
Required support
(1)
Need to support not only LTE but also GSM and W-CDMA
Multi-mode support
(2)
Need to support a number of frequency bands
Multi-band support

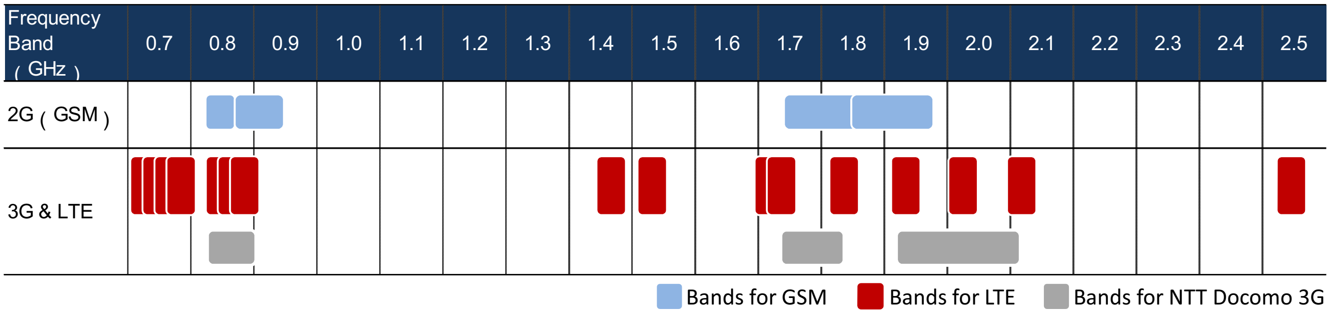
Source: Nikkei Electronics; Jefferies & Co.

We think that although the electronic component makers under our coverage will be impacted to some extent by multi-mode support, semiconductor makers will be far more impacted by multi-mode support, and electronic component makers will mainly be affected by multi-frequency band support.

What are Multi-frequency bands?

Mobile equipment will be required to support transmission and reception in many frequency bands, since frequency bands for LTE are not standardized and LTE has started operation under multiple frequency bands all over the world. Wireless equipment actually has to support seven to nine bands, as the equipment needs to support any type of LTE service in any country. Additionally, wireless equipment needs to support most frequency bands in order to allow end-users to use it all over the world.

Exhibit 84: LTE Services Use "Multiple Frequency Bands"



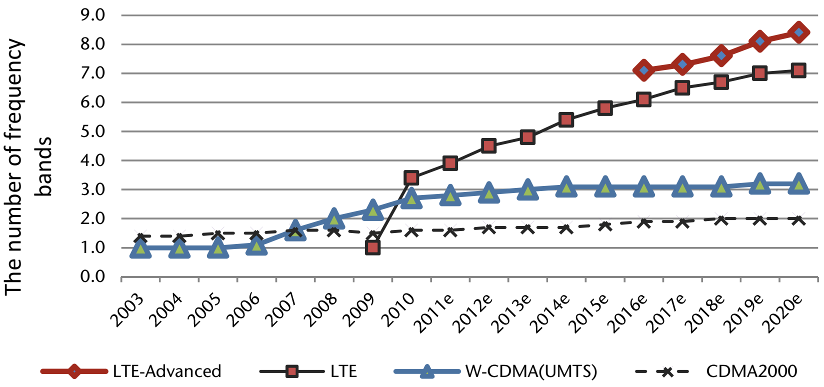
Source: Nikkei Electronics; Jefferies & Co.

Exhibit 85: Number of Bands for Globally Standardized Equipment

Standard	# of Frequency Bands	Frequency Bands
GSM, GPRS	4 bands	850M/900M/1.8G/1.9GHz
W-CDMA	3-5 bands	800M/1.9G/2.1GHz, etc.
LTE	7-9 bands	780M/860M/880M/1.5G/1.7G/1.8G/1.9G/ 2.1G/2.5GHz, etc.

Source: Nikkei Electronics; Jefferies & Co.

Exhibit 86: The Number of Frequency Bands Will Increase, Especially for LTE

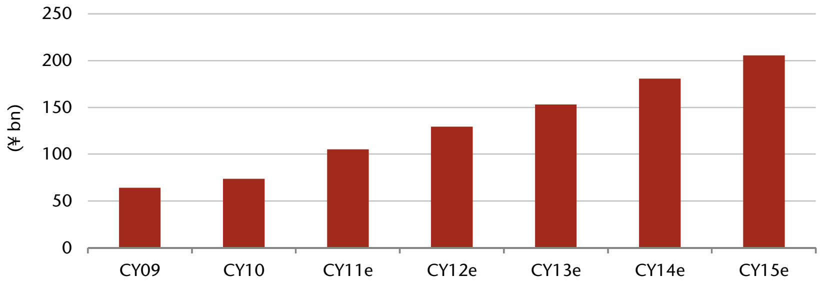


Source: Nikkei Electronics; Jefferies & Co.

Component content will increase

More electronic components will be necessary in RF (radio frequency) components for LTE terminals in order to support multiple frequency bands. For example, the number of SAW (surface acoustic wave) filters and SAW duplexers will increase in proportion to the number of frequency bands, where, in many cases, four SAW duplexers are used in a mobile device that supports four bands for a 3G system. Although a next-generation SAW duplexer that can support multiple bands with one duplexer is under development, we sense that it will take a very long time until the new duplexer is fully available for widespread use. The number of PAs (power amplifiers) will also increase as the number of bands rises, especially for LTE (although consolidation of PAs [multi-modes/multi-bands] is progressing).

Exhibit 87: SAW duplexer Market Forecast, 2009-2015E (¥ in billions)



Source: DG Research.

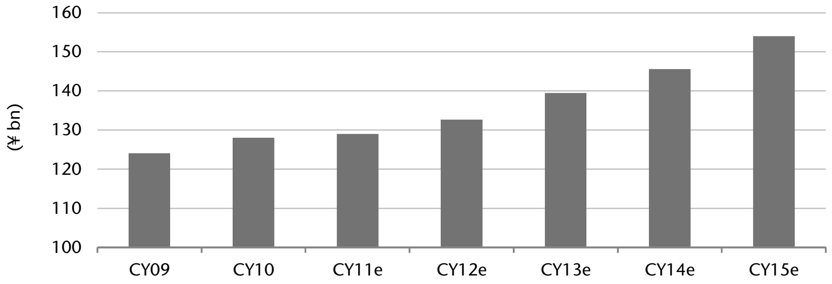
LTE employs an OFDMA (orthogonal frequency division multiple access) system. One of the reasons for using OFDMA is that OFDMA can combat multipath interference. The physical phenomenon of multi-path interference (or multi-path phasing) is the reflection of radio waves (that are transmitted from an antenna) off structures like buildings, mountains, or trees. Thus, the received signal is a sum of several reflections with different delays, different phase changes and different amplitude attenuations, which could create unstable signal reception, such as dropped mobile phone connections, missing wireless data packets, and lost radio reception.

MIMO (multiple input multiple output) has also been introduced for LTE. MIMO is also good at multipath phasing and is highly efficient in frequency usage, which will help MIMO play a key role in LTE, in our view. If MIMO is used, multiple receiving circuits will be necessary which will lead to an increase in the number of electronic components such as antenna switch modules and filters.

Module products will become increasingly required

While an increase in component content is basically positive for electronic component suppliers, it is not positive if the cost of equipment increases substantially, which could negatively affect the earnings of equipment makers or dampen end demand. If the cost increase in components exceeds an acceptable range, equipment makers would take measures to reduce component contents and the cost of equipment. We think that electronic component makers need to offer: (a) a module product which combines multiple components in order to contribute to the reduction of components or (b) new alternative technology and products which could replace existing components and reduce the number of components. Furthermore, modules are also being required to downsize printed circuit boards and reduce the costs of mounting electronic components on the boards.

Exhibit 88: FEM (Front End Module) Market Forecast, 2009-2015E (¥ in billions)



Source: DG Research.

Four types of Front End Modules (FEMs)

One of the important modules used in RF circuits for mobile equipment is front end modules (FEMs). We think that FEMs are largely categorized into the following four types:

(1) ASM (Antenna Switch Module, Antenna Switch + LC filter),

(2) RX Module (ASM + SAW filter),

(3) TX Module (ASM + PA), and

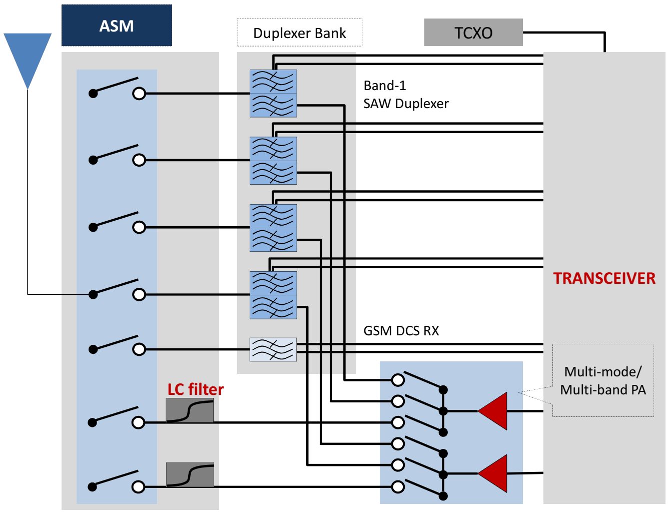
(4) FEMiD (Front End Module integrated Duplexer, ASM + SAW filter + Duplexer).

These FEMs were basically selected by mobile equipment makers depending on their design concepts when ASMs became very popular for mobile phones in GSM networks. TX modules are also used for GSM equipment. However, TX modules have less flexibility in circuit design, which has led to a better penetration rate of ASMs for high-end equipment, in our view. For high-end equipment in 3G, FEMiDs (where SAW filter and Duplexer makers have competitive advantages) will be used in many cases, whereas the iPhone4 has introduced new TX modules.

Key factor for success?

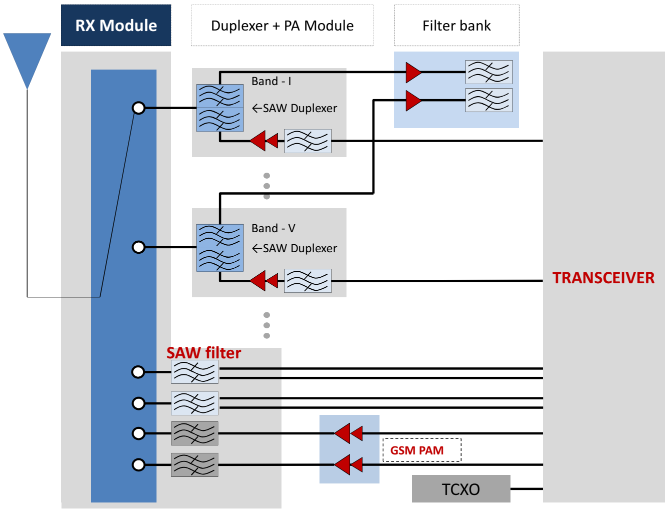
We think that these four types of FEMs will be considered for LTE equipment depending on equipment makers' design concepts. In our opinion, it is possible that FEMiDs could become more popular if Pas, which support multi-modes/multi-bands, were to be successfully developed in the near future. We believe that it is ideal for a component supplier to have strong capabilities in all key components — LC filters, SAW filters, SAW duplexers and PAs — in order to win the competition in FEMs for LTE.

Exhibit 89: ASM (Antenna Switch Module) in RF circuits



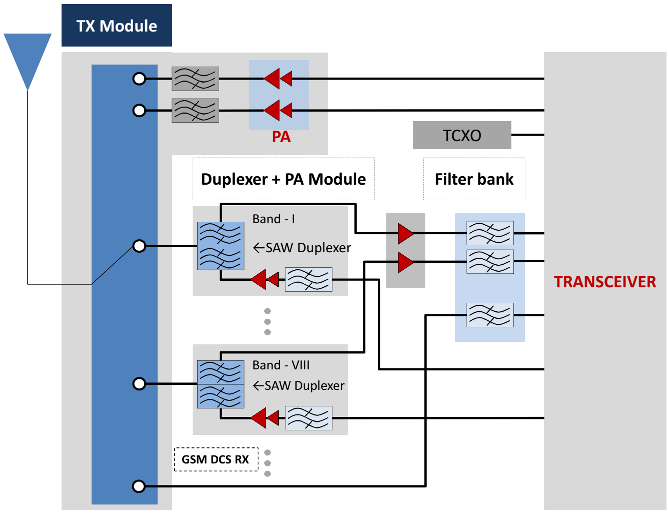
Source: Jefferies & Co.

Exhibit 90: RX Module



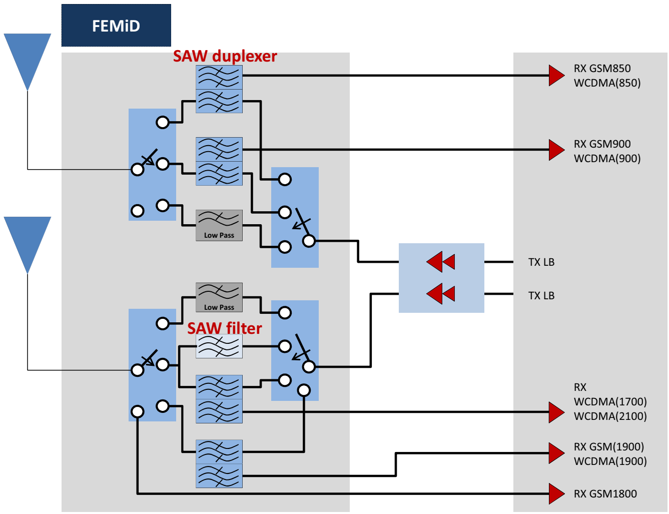
Source: Navian; Jefferies & Co.

Exhibit 91: TX Module



Source: Navian; Jefferies & Co.

Exhibit 92: FEMiD (Front End Module integrated Duplexer)



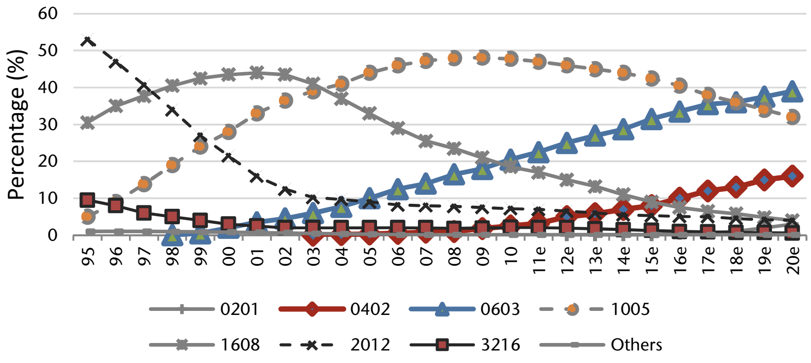
Source: Company data; Jefferies & Co.

Murata Has a Great Opportunity

We think Murata is one of the companies that has the best potential to be a winner in the era of LTE. Murata has been a leader in the development for wireless technologies and is capable of supplying SAW filters, SAW duplexers, antenna switch modules, LC filters, and WiFi modules for RF circuits, which will allow the company to benefit from market expansion of LTE mobile equipment, in our opinion.

Murata also contributes to downsizing and light-weighting. We also think that consumers' needs for downsizing and lighter-weight devices will accelerate, which will also help Murata play an important role as a total solution provider for RF circuits. The company has a strong competitive position and the top global market share in ultra-small sized MLCCs, such as 0603 (0.6mm x 0.3mm) and 0402 (0.4mm x 0.2mm).

Exhibit 93: MLCC Size Trend: 0603 and 0402 Will Play A Key Role



Source: Jefferies & Co. estimates.

Why has Murata purchased Power Amplifiers? Murata owns several key components of FEMs, such as antenna switches, LC filters, SAW filters and SAW duplexers. The company is very strong in the module product category thanks to its LTCC (low temperature co-fired ceramics) technology, which allows for the miniaturization of modules due to multi-layering of the circuit and also to the reduction in the number of mounted components. As a result, the company has high market share in ASMs, RX modules and FEMiDs.

On the other hand, it is very important for a supplier to internally develop and manufacture PAs, which are key parts in TX modules, and supply TX modules, when TX modules are employed in RF circuits. For instance, Skyworks Solutions (SWKS, 20.63, NC) and RF Micro Devices (RFMD, 6.22, NC) have strong competitive positions and high market share in TX modules, whereas Murata, which does not internally develop and make PAs, is not very competitive.

Finally, Murata will obtain Power Amplifiers. Murata is acquiring Renesas Electronics' (6723 JP, ¥529, NC) PA business. Renesas is a major supplier of PAs. The acquisition is expected to close at the end of this year, and will allow Murata to participate in the PA market. Since PAs are key components for TX modules, we believe the acquisition will strengthen Murata's competitive position in the TX module market. Murata will be able to support all types of FEMs and provide customers with optimal solutions in RF circuits. We believe Murata will become a very reliable partner for customers in designing RF circuits as well as mobile equipment**.**

Major equipment makers co-develop RF circuits with Murata, in many cases, due to its strong technological advantages, in our opinion. We believe that Murata has strong technological capabilities to co-develop with large customers and enough production capacity to supply a significant amount of key components, which will help the company survive a tough competitive environment.

LTE: Other Considerations for Chip-Makers

The emergence of LTE as a standardized 4G communications radio technology is already having investment consequences for carriers and equipment makers across North America and parts of Asia. A LTE and WiMAX transition to a 4G market is a revenue opportunity for 4G baseband chipmakers with an expected industry CAGR of 103% from 2010 through 2014 according to ABI Research. The significant smartphone growth that is in turn driving a rapid increase in mobile data traffic presses a need for a faster comms radio interface.

Although part of a potential cure for ramping data needs, LTE is not yet a complete standard. We believe, however, that, given the mobile data ramp, it is more likely that LTE rolls out faster than previous wireless specs have done.

We end our discussion of LTE with four standard setting issues and "bear" points on LTE that may or may not impact the constellation of chip-makers looking to roll out LTE solutions:

1) Voice over LTE (VoLTE) is late (vs. standards work for data transmission) and likely to be only achieved with a fallback to a circuit-switched network, which could limit the re-farming of 2G (or 3G) spectrum to LTE. Voice remains a "fat-margin" business line for operators that resist a VoIP solution on handsets where they can. This further increases the importance of a resilient 2G or 3G integration with an emerging LTE capability at leading modem providers. That, in turn, may speak of challenges for discrete 4G chipmakers looking to gain early advantage over the platform incumbent (Qualcomm, ST-Ericsson, Broadcom). The ITU, meantime, is unlikely to ratify VoLTE until the end of this year with the possibility of slipping into 2012. This may give extra time to discrete LTE chipmakers to develop (or partner for) a viable 2G/3G solution in the near-term.

2) There has been a build-up of 20 frequency bands to support worldwide in FDD and another 10 in TDD – a far cry from the simple two band success of GSM networks. Yet it seems the industry will focus on only five or six key bands over the next one to two years. In these early stages of LTE rollout, we believe it is vital to get this right – interoperability, speed, handover to 2G/3G and cell-to-cell handoff. Later development will focus on full global roaming. But for now, major city/region roaming in country will suffice (e.g., U.S. or China). The lowered hurdle of entry into the LTE modem space may see a string of

newcomer solutions emerging. Besides the benefit of competitive options available to handset OEMs, the space could see M&A activity should incumbents be compelled to buy rather than develop in-house LTE solutions.

3) LTE-Advanced is the real “4G” and looks to have been ratified in 1Q11 with the release 10 of the 3GPP specifications on wireless communication (see www.3gpp.org). Yet all of the network rollout planned for this year and next focuses on Releases 8 and 9 (mainly 8) with which available LTE-modem designs (Qualcomm, ST-Ericsson, Sequans) are fully compliant.

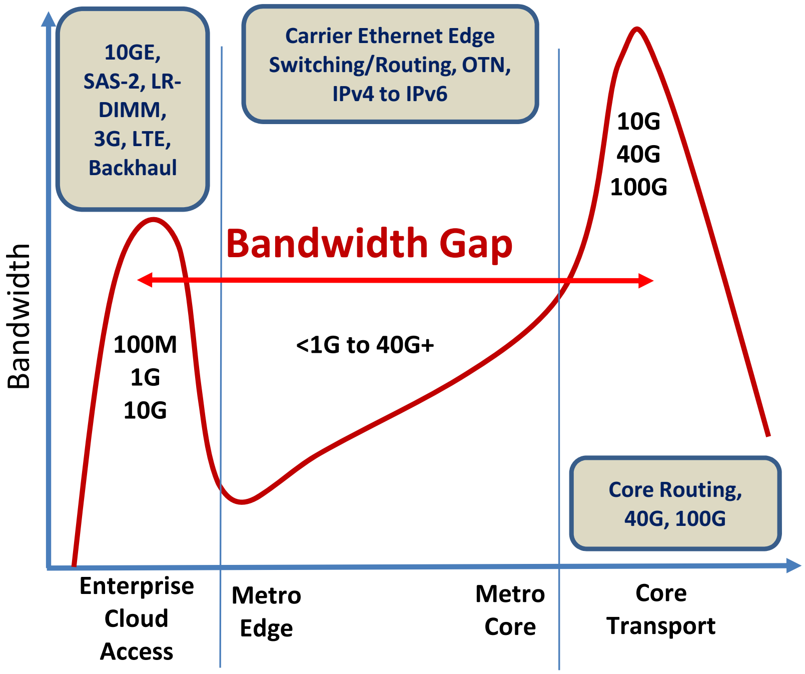
4) Mobile data tariffing needs to change as operators have gained little extra revenue from the recent data tsunami. This may inadvertently affect data traffic and may see a longer shelf life for existing 3G standards (HSDPA, HSUPA, HSPA+). The data ramp may only slow with the advent of tiered data packages by carriers. It is unlikely to stall the growth in demand for smartphones and tablets in the meantime. As such, the rollout of 4G networks to support data demand is even more likely. In addition, we think it unlikely that Apple, for example, would allow its brand to suffer and not support 4G data downloads should others (such as HTC) attempt a lead in this space.

2) Connectivity Infrastructure

As smartphones, tablets, IPTV, connected automobiles and cloud computing evolve, they place increasing requirements on the communications infrastructure, in terms of the frequency at which the network is accessed, the duration and the amount of data transceived in each access, and the level of intelligence required in the network for the type of application or service accessed. As different parts of the network are upgraded at different times, a “bandwidth gap” is created, which we believe continually shifts the focus of network upgrades (e.g., wireline to wireless) to close the bandwidth gap.

Different parts of the communications network infrastructure are upgraded at different times, creating a "bandwidth gap" that continually shifts the focus of infrastructure upgrades, driving secular product cycles for semiconductors

Exhibit 94: Bandwidth Gap

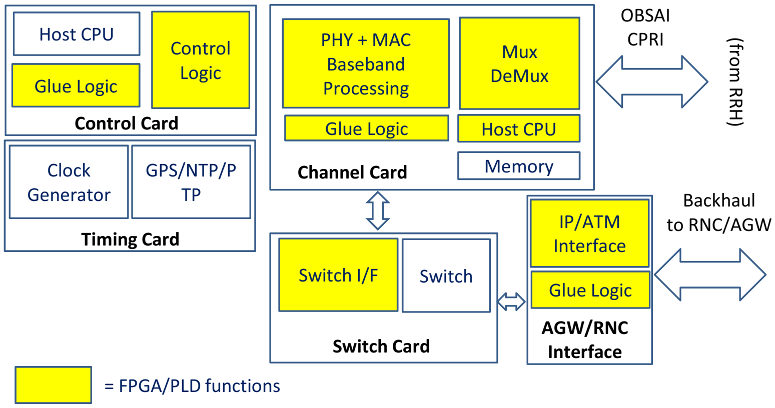


Source: Company reports; Jefferies & Co.

As the wireless infrastructure for 2G/3G and LTE is built out over the next ten years, we expect the market for semis shipping into wireless base stations to grow

We expect telco emphasis on lower cost to drive demand for a higher number of smaller form-factor base stations, which we believe increases opportunities for mid-range FPGA, and ASIC/ASSP, relative to high-end FPGA

Exhibit 95: Semiconductor Opportunities in Wireless Base Station

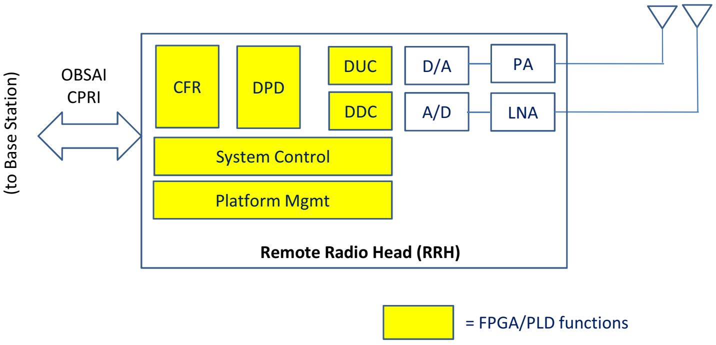


Source: Company reports; Jefferies & Co.

With more demanding requirements placed on spectral efficiency, we expect a higher level of competition for more efficient solutions

Our proprietary checks indicate NETL's Optichron DFE is likely to be a potential winner relative to high-end FPGA

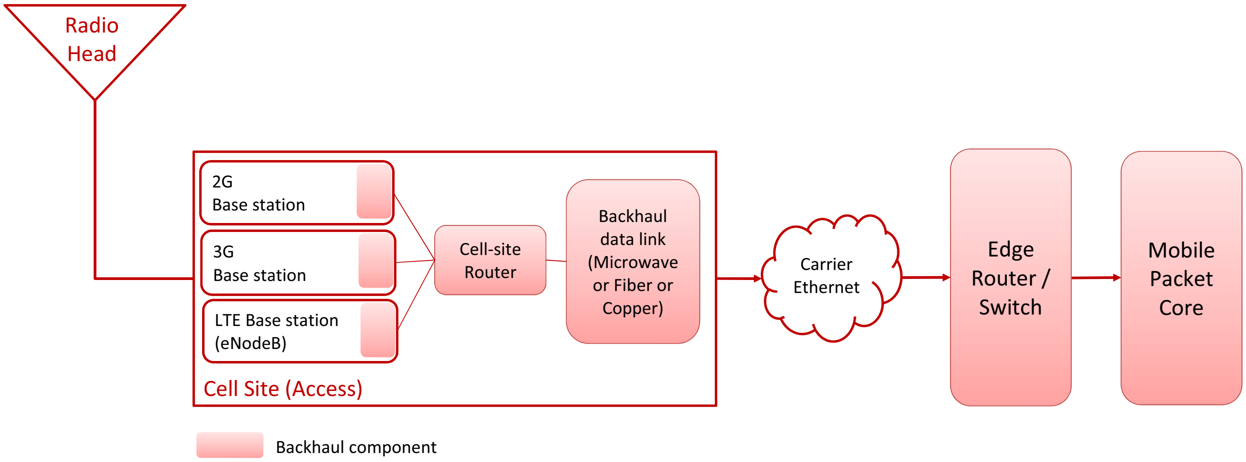
Exhibit 96: Semiconductor Opportunities in Radio Head



Source: Company reports; Jefferies & Co.

The chart below highlights the different categories of equipment within the mobile backhaul market, which consists of equipment used to transport voice, data and video between wireless base stations and the network core.

Exhibit 97: Mobile Backhaul Semiconductor Opportunities

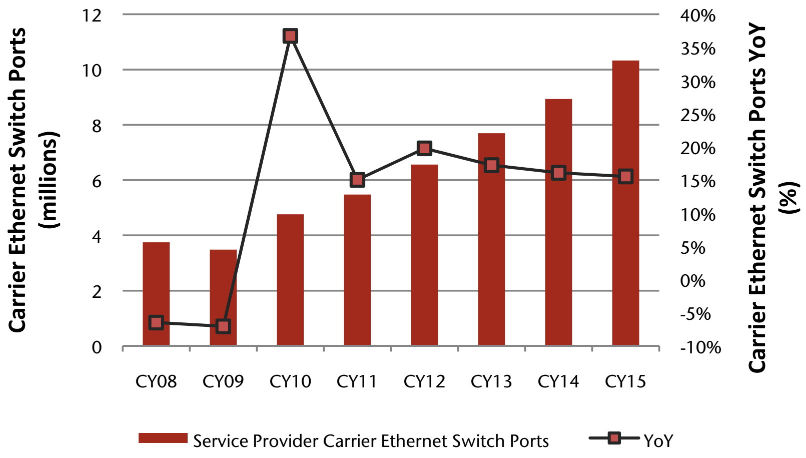


Source: Jefferies & Co.

We think operator requirement to support legacy TDM base station interfaces along with newer packet interfaces represents a strong driver of equipment with hybrid TDM/packet interfaces. We note PMCS's Wintegra is uniquely positioned in such hybrid equipment, with its hybrid TDM/Packet interfaces, in our view. Over time, we expect an increasing portion of the network to transition to Carrier Ethernet, but history suggests that legacy interfaces typically need to be supported for longer than initially anticipated.

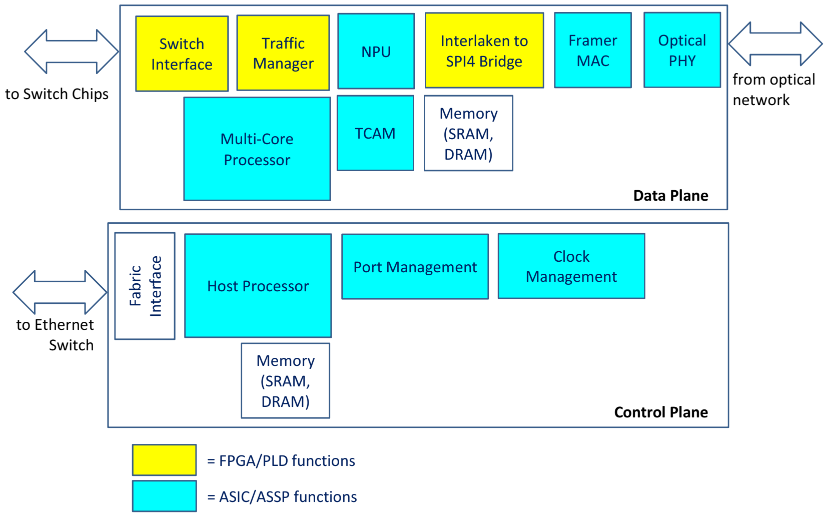
We expect strong growth in Service Provider Carrier Ethernet Switch ports to drive revenue growth for NETL, CAVM, EZCH, ALTR, XLNX, LSCC, and PMCS

Exhibit 98: Service Provider Carrier Ethernet (CE) Switch Ports



Source: Infonetics; Jefferies & Co.

Exhibit 99: Snapshot of Semiconductor Suppliers into CESR - Line Card Functional Block Diagram



Source: Jefferies & Co.

FPGA Providers:

ALTR, XLNX, LSCC

ASIC/ASSP Providers:

NPU: EZCH, PMCS

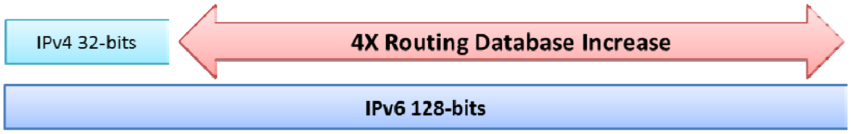
TCAM: NETL

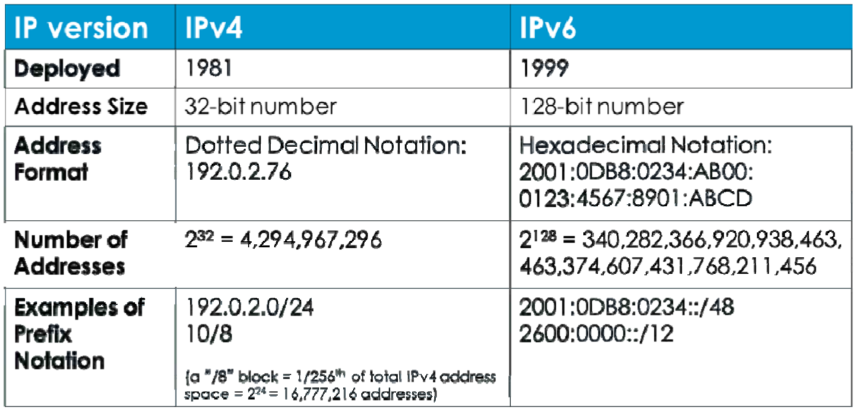
Multi-Core Processor: NETL, CAVM

Framer MAC: PMCS

Optical PHY: IPHI, NETL

Exhibit 100: IPv4 vs. IPv6 transition drives higher network processing





IP version	IPv4	IPv6
Deployed	1981	1999
Address Size	32-bit number	128-bit number
Address Format	Dotted Decimal Notation: 192.0.2.76	Hexadecimal Notation: 2001:0DB8:0234:AB00: 0123:4567:8901:ABCD
Number of Addresses	2^{32} = 4,294,967,296	2^{128} = 340,282,366,920,938,463, 463,374,607,431,768,211,456
Examples of Prefix Notation	192.0.2.0/24 10/8 (a "/8" block = 1/256th of total IPv4 address space = 2^{24} = 16,777,216 addresses)	2001:0DB8:0234::/48 2600:0000::/12

Source: Company reports; arin.net; Jefferies & Co.

We believe that higher network processing requirements will drive secular demand for NETL's KBP

We think investor concerns around NETL losing KBP share to Cisco's in-house solution are overdone, as we expect Cisco's house solution to play in the lower-end market

We note that NETL's KBP business grew on average at 9% per quarter from 3Q09 to 1Q11

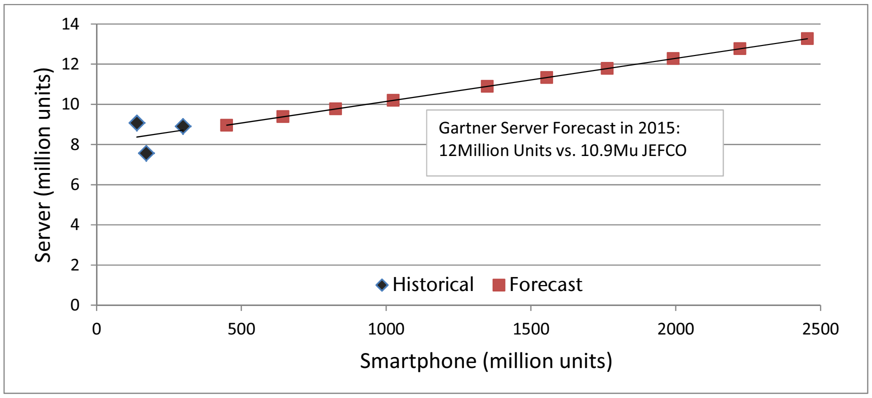
3) Cloud / Data Center

As Mobile terminals grow, we think processing and data storage will increasingly be located in the Cloud, and we expect to see increasing demands on both the Cloud and data centers.

Our analysis and checks indicate growth in mobile devices (particularly smartphone and tablet) and data traffic is a direct driver of growth in Cloud/data center infrastructure, which is primarily made up of servers, storage, and networking interconnects.

We extrapolate the linear relationship between servers and smartphones to estimate the server market in 2015

Exhibit 101: Server and Smartphone Unit Scatter Plot

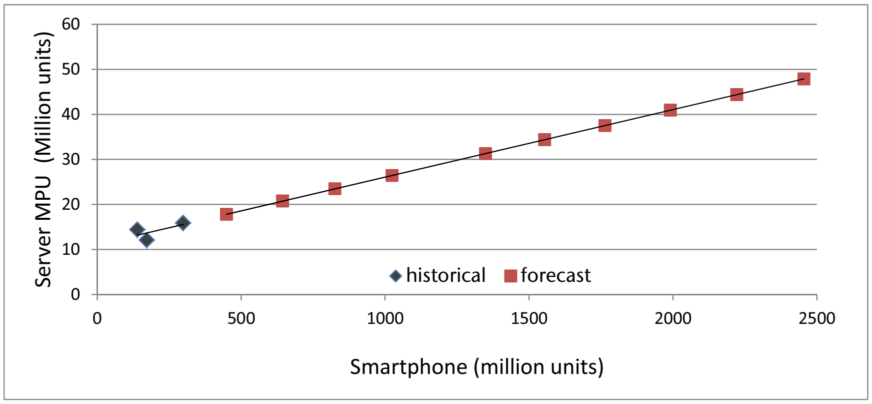


Source: Gartner; Jefferies & Co.

Our server unit forecast of 10.9 million in 2015 is based on our assumption of a linear relationship with smartphone units and compares with Gartner's forecast of 12 million server units in 2015.

We extrapolate the linear relationship between server MPU and smartphone to estimate the server MPU market in 2015

Exhibit 102: Server MPU and Smartphone Unit Scatter Plot



Source: Gartner; Jefferies & Company

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How the Software Operating Model Will Change as a Result of Mobility

Executive Summary

- **Software as a Service (SaaS) applications are naturally extended to mobile devices and the progression of Cloud Computing will make applications ubiquitous on smartphone and tablets, in our view. Traditional client server applications are at a disadvantage and these vendors will be challenged to extract revenue by extending their applications to mobile devices.**
- **Mobility will change traditional enterprise applications. The forces that have driven consumer application innovation on smartphones and tablets are now reaching the corporate world. We think a combination of: 1) real-time data and analytics, 2) location based services, and 3) social applications will begin to reshape the enterprise application market.**
- **Machine-to-Machine ("M2M") connectivity will spur a new wave of system optimization. New applications, data management, monitoring and back end infrastructure will be needed.**
- **Mobile Data Makes Big Data Even Bigger. The combination of growth in the number mobile devices and the substantial increase of data traffic per device is creating massive amounts of data. Much of this data will also reflect user location and other elements unique to mobility. This data explosion creates large opportunities for software companies that store, manage, analyse and leverage data.**
- **App stores have changed the distribution and pricing model for software. Distribution is now in the hands of device/OS vendors and prices on software have fallen.**

An Inflection Point in Software

Mobile software applications are not new to the enterprise. Avis car rental introduced a handheld computing terminal for car returns in 1987; companies like Symbol and Telxon sold wireless devices and software to retailers in the mid 1990s; and we recall being handed a Palm 7 device to manage our schedule at SAP's user group event in 2001.

For most of the last decade, the picture didn't change very much. Most enterprise mobile software and devices existed for niche functions, and broad enterprise usage was limited due to a poor user experience. The one exception was perhaps RIM's BlackBerry (RIMM, $32.49, Hold) where a combination of form factor, security, proprietary network and push technology meant that employees had a legitimate handheld device for email, calendaring and voice. It was simple, effective and provided corporate users with their first taste of mobility.

The watershed event, of course, was the release of Apple's iPhone in 2007 when consumers suddenly had a legitimate smartphone, with access to email, video, maps and, most importantly, a browser experience that was pretty similar to the PC. But a number of other trends in technology are also taking place, most notably the rise of software as a service, virtualization, cloud platforms and new ways to manage and analyse "big data." We think these are inexorably linked with mobility and will continue to have a profound impact on enterprise software over the next five to ten years.

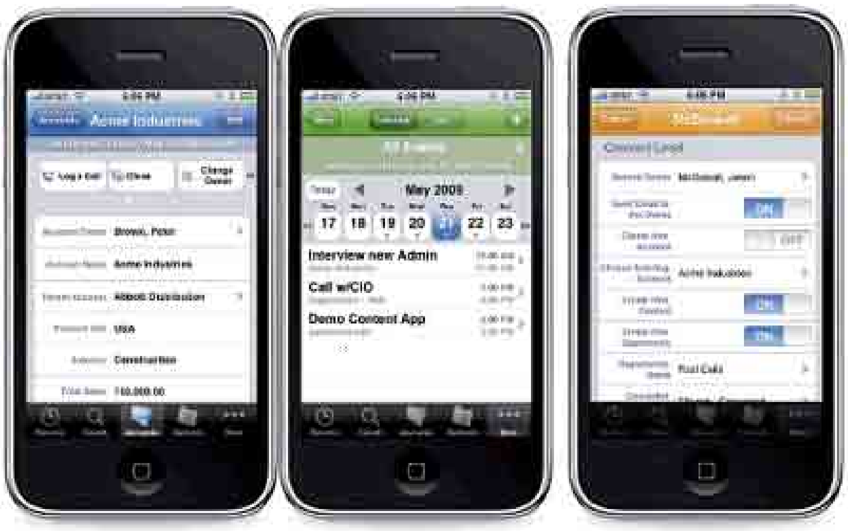
These Apps Were Made for Walking

Salesforce.com paved the way for a new breed of enterprise applications that are delivered to users via the Internet and share much of the look and feel of consumer Internet applications like eBay and Amazon. These applications have their processing power and data storage residing in the cloud (i.e., third party public data centers) rather than on local devices, and so naturally lend themselves to mobile devices. In addition, these applications allow users to access applications, storage, security and up-time on the scale of best-of-class data centers and so are very attractive to small and mid-size business that would otherwise not be able to access these resources. Just as consumers are attracted to cloud services such as Netflix or iTunes because of the user experience, convenience, and ubiquitous access, so are SMEs attracted to cloud-based applications. It is no surprise that cloud-based services such as Google Apps, Gmail and even Salesforce.com found SMEs were the early adopters of their services.

The business model of SaaS (subscription) vs. traditional applications (perpetual licensing) aligns well with mobile devices which are also subscription based for data and voice access

As a result of the way SaaS applications are delivered to users, the vast majority of vendors offer mobile applications at no extra charge for existing subscribers. Examples include Salesforce.com, Concur Technologies (CNQR, $41.82, Buy), SuccessFactors (SFSF, $23.36, NC) and Workday. The user expectation is that an application should be accessible on a ubiquitous basis from a PC, smartphone or a tablet. The user interface and functionality may be a bit more restricted on a smartphone, but critical functions and features such as alerts are generally supported. We also believe the business model of SaaS applications (subscription) rather than that of traditional applications (perpetual licensing) also aligns well with mobile devices, which are also subscription based for data and voice access.

Exhibit 103: SaaS Apps Are Automatically Mobile Ready . . .



Source: Salesforce.com.

We would compare and contrast this with the stance taken by traditional application vendors from the client server world, which often try to charge for mobile extensions and have to create new ports for their applications to mobile devices. SAP (SAP, $54.51, Hold), for example, bought Sybase in 2010 in part for its mobile technology. SAP sells a number of components including middleware and device management software, which allow partners and customers to build upon these to extend applications to mobile devices. However, SAP is attempting to charge customers for both the mobile middleware and the applications that SAP and its partners build upon the platform. This additional complexity and cost makes this a less attractive proposition for customers relative to cloud based applications. As a result, many traditional client server application companies looked to move into SaaS-based applications in areas where they had proved most promising. However for a number of reasons these efforts have proved unsuccessful. It seems that the transition of traditional application vendors into the world of the cloud and mobility remains challenged.

The transition of traditional application vendors into the world of the cloud and mobility remains challenged

Virtualization and Cloud Fuels Mobility

Virtualization is viewed as the “fabric” for the cloud. Virtualization allows for much better utilization of compute resources, but also creates the potential to scale compute resources elastically and therefore provide massive access to shared compute and storage. We believe there are two main ways in which virtualization will continue to the trend of mobility for enterprise software: desktop virtualization and server virtualization.

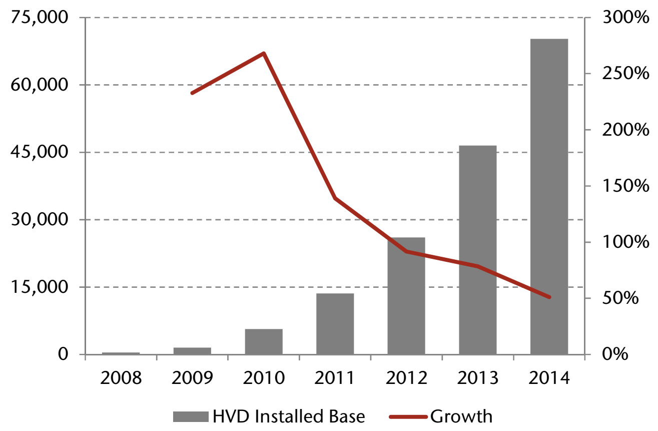
Desktop Virtualization

This allows users to get access to applications or their entire desktop image on any device, ranging from a thin client terminal to mobile devices such as smartphones and tablets. There are various ways to virtualize the desktop, ranging from application remote access through to full-blown Virtual Desktop Infrastructure (VDI). A number of companies play in this market today, including Citrix (CTXS, $60.43, NC) with an estimated 47% share, VMWare (VMW, $94.36, NC) and Red Hat. Other approaches also exist, such as Ignition from LogMeIn (LOGM, p$31.25, NC).

The demand for ubiquitous access to corporate desktops and applications as well as the concept of employee bring-your-own-device to the workplace is driving growth in this market. With over 683 million corporate desktops globally (per IDC) and less than 5% virtualized, it appears there is ample room for growth. However, we think the size of the market ultimately depends on what happens to Microsoft (MSFT, $26.60, NC) and how the existing Microsoft-centric software infrastructure within companies evolves over coming years.

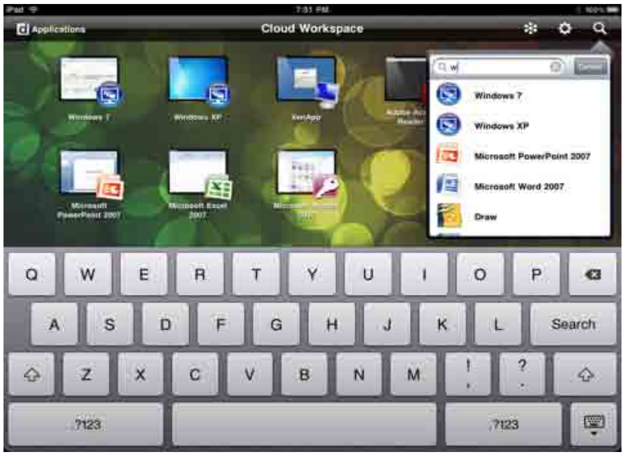
But of course, much of the success of the future of desktop virtualization will depend on what happens to the existing enterprise computing environment in which we all work today. If Microsoft were to be successful in its efforts to become a major player in the smartphone and especially the tablet market, we would expect native versions of Office and the Outlook client to become widely used on these devices, which would lessen the need for virtualized desktop access for these applications on advanced mobile devices. In addition, if Microsoft’s cloud applications efforts accelerate then they could become accessible on mobile devices on increasingly fast and ubiquitous networks. While it remains to be seen whether Microsoft will support cloud-based versions of Office on every platform (for example, Office 365 is not accessible from the iPad today), this could be a long-term deal-breaker for mass market desktop virtualization.

Exhibit 104: Hosted Virtual Desktops are Rapidly Growing



Source: Gartner Group.

Exhibit 105: Allowing Access on Smartphones and Tablets



Source: Citrix Receiver.

Server Virtualization

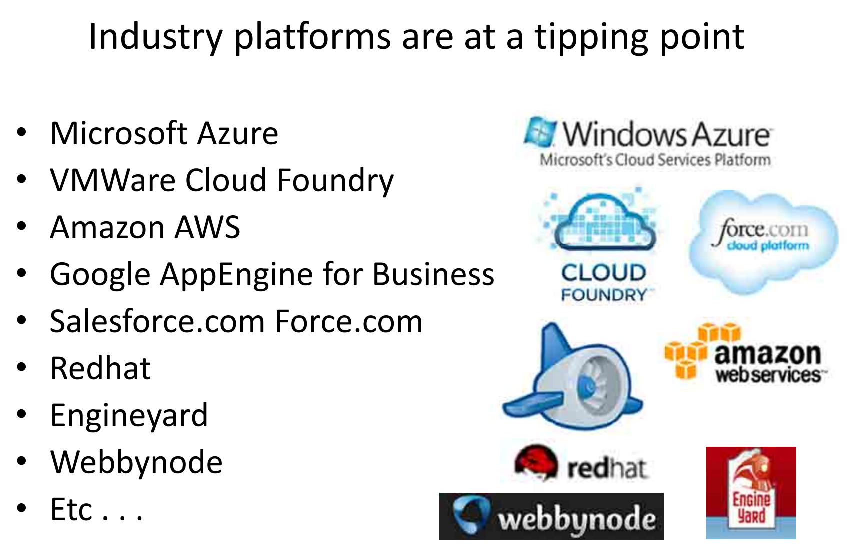
As more applications are moved to virtualized infrastructure, the potential exists for those applications to be run on shared infrastructure in the future. VMWare's vCloud strategy, for example, is focused on letting companies run, secure and manage applications on private clouds to start with (i.e., a company's own data center) but also be able to port these applications to similar vCloud infrastructure that runs in hosted public data center. The concept is that a company can ultimately move a lot of its applications to run as SaaS applications on cloud infrastructure over time. This should accelerate the ability to access corporate applications and services from mobile devices.

Infrastructure and Platform as a Service technologies take advantage of virtualization to allow them to scale compute resources horizontally and elastically. Like many areas of technology in recent years, the consumer side has led the enterprise. Cloud services exist in abundance in the consumer world (think Google, Facebook, YouTube, Twitter, iTunes, Netflix, etc.), but are only now starting to emerge more meaningfully for the enterprise. These new Infrastucture and Platform as a Service offerings include Salesforce.com's Force.com, Amazon AWS, Microsoft Azure and VMWare vCloud. These cloud services offer access to either scalable infrastructure components (like processing power, storage, database and messaging services) or to development platforms (where you write code on top of a pre-provisioned infrastructure stack).

These cloud services play into the theme that users expect to have ubiquitous access to services regardless of the device they are using or where they are. We expect these platforms to have a profound impact on the enterprise software landscape over coming years, disrupting existing incumbent platforms and proving the building blocks for a new generation of applications.

These platforms are also becoming increasingly readied as platforms providing cloud services to mobile devices. For example, Amazon introduced mobile Software Developer Kits for Amazon Web Services in December 2010. Mobile applications using the SDK can now use many of Amazon’s infrastructure components in AWS, including Simple Storage Service (Amazon S3), Database (Simple DB) and Messaging (Amazon SQS and Amazon SNS).

Exhibit 106: New Cloud Platforms Automatically Extend Apps to Mobile Devices



Industry platforms are at a tipping point

- Microsoft Azure
- VMWare Cloud Foundry
- Amazon AWS
- Google AppEngine for Business
- Salesforce.com Force.com
- Redhat
- Engineyard
- Webbynode
- Etc . . .

Windows Azure
Microsoft's Cloud Services Platform
CLOUD FOUNDRY
force.com cloud platform
amazon webservices
redhat
webbynode
Engine Yard

Source: Company data; Jefferies & Co. estimates.

Mobility Will Create Two New Areas of Enterprise Apps

We do not see the future being one of simply extending existing enterprise applications to mobile users. Most field sales forces already have mobile applications available to them and we doubt that if you work in finance, planning or control that you will need to have access to your core accounting application on a mobile device. However, we think a new generation of apps that can alert us real time to changes in data that is relevant to our roles, that leverage location based information, and which allow us to easily collaborate and share data with others will represent the applications of the future.

New Apps Driven by Data, Location and Social

John Doerr is widely credited with the phrase SoLoMo – where the combination of Social Applications, Location Awareness and Mobility will fuel a new wave of applications

The forces that have driven consumer application innovation on smart-phones and tablets are now reaching into the corporate world. Numerous examples of apps that are focused on business users rather than consumer users are beginning to emerge. We think these apps will be brand new and will take advantage of elements such as: i) real-time data and analytics; ii) location based services and iii) social applications that will begin to reshape the enterprise application market in the future. We agree with what John Doerr of Kleiner Perkins and others call SoLoMo (Social/ Local/ Mobile) as the building blocks for applications change. Some of these new applications include:

Virtual meetings. Companies like Citrix with GoToMeeting (www.gotomeeting.com) and Cisco with WebEx (www.webex.com) are changing the collaboration market. Instead of tele-presence being provisioned by proprietary equipment within office meeting rooms, new applications allow users to collaborate on mobile devices in ways that were not previously possible. Similar to Apple's FaceTime, we have seen new services such as Citrix's GoToMeeting HDFaces emerge that replicate what has happened in the consumer world. We think collaboration on mobile devices will continue to evolve and expect relatively low cost services on mobile devices to cannibalize the traditional market tele-presence and video-conferencing market. New cloud based collaborative content aggregators such as Versly (www.versly.com) and process specific collaboration offerings such as Sales Crunch (www.salescrunch.com) are also emerging as new enterprise applications.

Mass Market VoIP. Companies like Skype (www.skype.com) and Truphone (www.truphone.com) started by providing VoIP services to consumers, but are rapidly becoming the mainstay of businesses who are looking to lower communications costs when users are connected to fixed line Internet. We believe this market will continue to evolve especially post Microsoft's purchase of Skype. We expect low cost VoIP service to become widely integrated into unified communication services such as Microsoft Lync. But we could also see much more aggressive steps taken by Microsoft. If Microsoft were to leverage Skype and perhaps offer VoIP over the mobile Internet thereby negating the need for voice data plans, we could see this being very disruptive to share in the smartphone market given the significantly lower cost service plans that could be offered.

Payments. Mobile payments is a very large area and we have devoted a separate section of this report to it. We mention payments here as an area where mobile applications are evolving rapidly. Companies such as Intuit (with GoPayment, www.gopayment.com) and Square (www.square.com) are providing readers and software that can be run on smartphones and tablets to allow businesses to be able to accept credit and debit cards without investment in traditional Point of Sale (POS) and payment terminal infrastructure that is often costly. Start ups and small businesses have led the way with these alternative services, but of course it doesn't stop there. Apple stores have been using iPhones with card readers and software for some time and we think it is only a matter of time before these go mainstream. In addition, we are starting to see new POS offerings emerge from the likes of Pose (www.getpose.com) that are looking to disrupt traditional suppliers.

Social and Networking. We have seen the emergence of many social technologies for use by business users, such as Salesforce.com Chatter (www.chatter.com), Jive Software (www.jivesoftware.com) and Tibco Software's (TIBX, 22.38, NC) Tibbr (www.tibbr.com). Many of these applications are an attempt to introduce the concepts of updates and feeds made popular many consumer social applications such as Facebook into the corporate environment. These technologies hold a lot of promise as they offer an alternative way to collaborate and also act as an integration point for other software and services (just as your Facebook username and password have become the gateway for many other services such as Hulu or Farmville). In addition, we have seen a number of other applications that are focused on business networks emerge. These vary from contact sharing such as Bump (http://bu.mp/) to other specialist networks such as LinkedIn (LNKD, $84.12, NC).

Loyalty. We have seen an explosion of coupon and other loyalty based-consumer services and are now beginning to see new a new wave of applications emerge that are focused on location based affinity marketing for local business. Examples include PlacePop (www.placepop.com), Shopkick (www.shopkick.com) and Foursquare (www.foursquare.com).

Travel. Companies like TripIt (now owned by Concur) and Flight Track Pro are changing the user experience for business travel. Travel itineraries are accessible from users' smartphone or tablet and services such as flight delays and cancellation alerts are becoming mainstream. These are evolving, allowing the business traveller to make changes to itineraries on the fly and within corporate policy, negating the need to call a corporate travel agent. Even consumer based apps such as Gowalla (www.gowalla.com) are beginning to offer more content and services relevant to business travellers.

File Access and Storage. The ability to access files from any device is an area of growth. Vendors such as DropBox (www.dropbox.com) have focused on this as a way to allow consumers access photos, files, videos regardless of device. Symantec, as part of its Consumer line-up, has Norton Connect which allows device access (Android, iPhone) to any file type that has been backed up through Norton Backup / 360. Symantec has historically introduced features in their consumer products prior to an enterprise version and we expect the company to extend the Connect functionality to its enterprise products, through it is likely limited to organizations that utilize online backup. We see many opportunities for these types of services to be extended into the corporate world so that users have perpetual access to their data and content.

New Apps Driven by Machine to Machine Mobility

Another domain that we think holds promise for enterprise software is M2M mobility. We expect rapid growth in machines that use network resources to communicate with remote applications and infrastructure for the purpose of new analysis, monitoring and control. This mega trend is being driven by the expansion of: i) mobile network coverage – for example, fleet management in the U.S. has already moved away from satellite communication toward mobile networks; ii) increased bandwidth on networks - operators are already deploying network elements that support M2M separately from the traditional network infrastructure, such as GGSN and PDSN standards; iii) telematic and telemetry applications, which create big operational efficiencies. These can range from remote equipment and moving vehicle diagnostics to mobile payments. In some areas, governments are mandating telematics (for example the EU eCall accident location initiative); and iv) operators looking to expand services offerings.

Growth in M2M devices will be driven by myriad new applications that use real data to more accurately monitor, regulate and optimize systems. Traditional M2M systems have not necessarily been driven by mobility. For example, the wave of smart metering by utilities companies is based on bi-directional sensors that can be connected to the fixed line Internet. These sensors connect consumers to the grid providing them with monitoring of energy use which varies in price according to the time of day. Utilities can better anticipate peaks and troughs in demand and allow for greater analytics and segmentation for optimal provisioning. However, with advancements in sensor and power technology coupled with more and cheaper mobile bandwidth, we expect to see strong growth in M2M driven applications. Examples of areas where we expect to see M2M applications are included in the table below.

Exhibit 107: Examples of M2M Applications

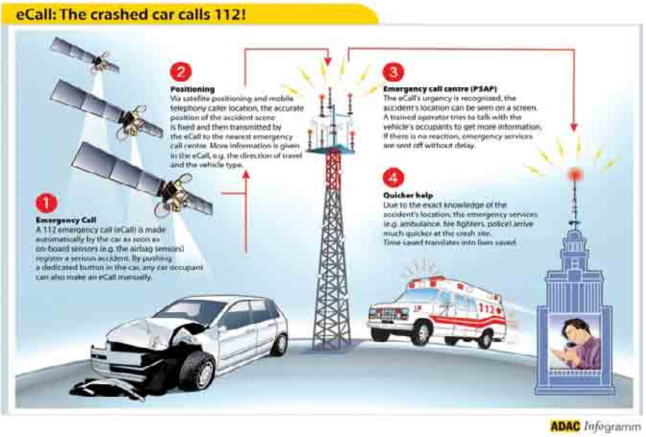
Banking	Mobile Payments
Healthcare	Remote Real-Time Patient Monitoring
Security	Remote Real-Time Surveillance
Oil and Gas	Oil and Gas Field Asset monitoring
Transport	Intelligent Transportation Networks
Retail	Location based promotions, Remote Vending Management
Automotive	Real-time engine monitoring
Industrial	Remote Diagnostics and Updates

Source: Jefferies & Co. estimates.

Exhibit 108: Remote Patient Diagnostics

Source: Airstrip Technologies, Jefferies & Co.

Exhibit 109: eCall Accident Location Notification



Emergency Call
A 112 emergency call (eCall) is made automatically by the car as soon as on-board sensors (e.g. the airbag sensors) register a serious accident. By pushing a dedicated button in the car, any car occupant can also make an eCall manually.

Positioning
Via satellite positioning and mobile telephony caller location, the accurate position of the accident scene is fixed and then transmitted by the eCall to the nearest emergency call centre. More information is given in the eCall, e.g. the direction of travel and the vehicle type.

Emergency call centre (PSAP)
The eCall's urgency is recognized, the accident's location can be seen on a screen. A trained operator tries to talk with the vehicle's occupants to get more information. If there is no reaction, emergency services are sent off without delay.

Quicker help
Due to the exact knowledge of the accident's location, the emergency services (e.g. ambulance, fire fighters, police) arrive much quicker at the crash site. Time saved translates into lives saved.

Source: ADAC Infogramm, Jefferies & Co.

M2M software plays include IBM as well as several private companies, including Red Bend software, nPhase, Jasper Wireless, and Axeda

One of the tough questions to answer is how investors should play the M2M market from a software vendor perspective. Elsewhere there seem to be more obvious ways to play the trend such as embedded wireless module equipment vendors such as Sierra Wireless (SWIR, $7.30, Hold) and M2M communication providers (most major network operators). However, on the software front we believe much of the opportunity resides with large integrated software and services providers such as IBM (IBM, $171.91, NC) with their Smart Planet initiative that spans many M2M domains, and perhaps some specialized players most of whom are private companies such as Red Bend software, nPhase, Jasper Wireless, and Axeda. We also think the providers of Mobile development platforms (which are predominantly private companies) such as Antenna software and Syclo are plays on this trend.

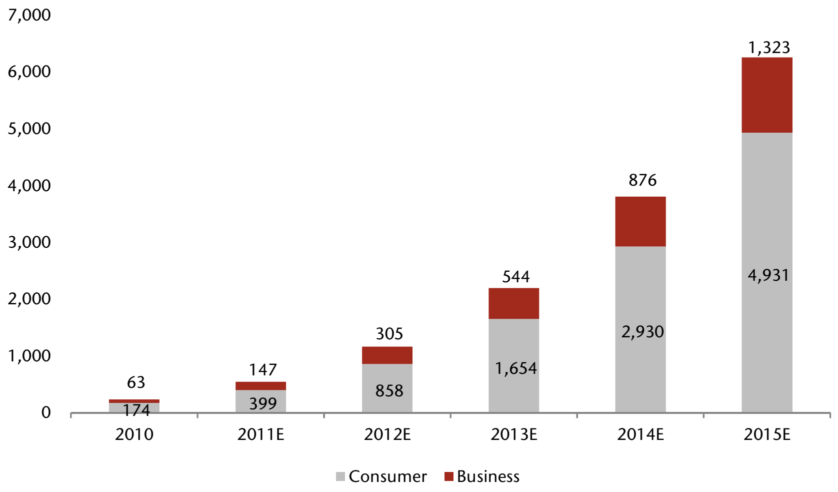
Mobile Data Makes Big Data Even Bigger!

Cisco estimates that connected devices could top 15B by 2015 and IBM estimates the number of connected devices will grow from 7 billion in 2010 to 50 billion in 2020

Smartphones and Tablets are already out-shipping PCs and we expect the number of mobile devices to grow rapidly over coming years. As outlined earlier in this report, our global handset and tablet hardware team believes that 3G and 4G subscribers globally will grow from 1.2 billion in 2010 to over 6 billion in 2020. As we have outlined, we also predict strong growth in machine to machine (M2M) mobility, where devices communicate with each other via the network. Cisco estimates that connected devices could top 15B by 2015 and IBM estimates the number of connected devices will grow with a 22% CAGR from 7 billion in 2010 to 50 billion in 2020.

Not only are mobile devices growing rapidly, but the amount of data traffic per device is also growing rapidly. In 2010 global mobile data traffic was 237 petabytes a month (for perspective this is 3X total global Internet traffic of 75 petabytes back in 2000). In 2010 average traffic per smartphone was 79MB compared with only 35MB per month in 2009. In addition, new devices are accelerating this trend, as it is estimated that in 2010, tablets generated 5X more traffic than the average smartphone. According to Cisco, global mobile traffic is expect to increase 26X between 2010 and 2015, or a 95% CAGR, reaching 6.3 exabytes per month by 2015.

Exhibit 110: Mobile Data and Internet Growth – Consumer and Business, 2010-2015E (in petabytes of data per month)



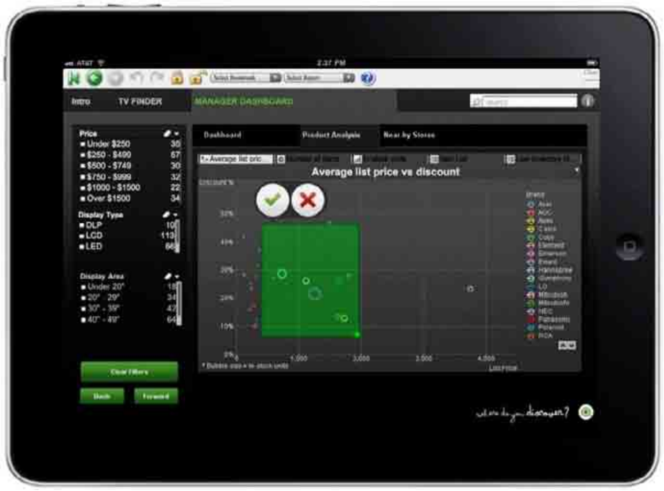
Source: Cisco Visual Networking Index, June 2011.

This explosion of data has important implications for both the back-end software used to store and manage the data, as well as the front-end to query and analyse the data. In addition, because we are now carrying around our computers in the form of smartphones and tablets, we expect to receive and react to data real time.

As a result, we are seeing growth in many areas of analytics and business intelligence. Traditional legacy BI players such as Microstrategy (MSTR, $122.88, NC) and traditional data warehouse players such as Teradata (TDC, $52.36, NC) are enjoying a renaissance, as companies begin to step up their efforts to tackle the escalation in data volumes.

We are also seeing a new wave of players emerge that are leveraging new technologies to address the issue of the size of the data and the real time nature by which we want to be able to consume, query and analyse that data. Qlik Technologies is a good example of a company taking advantage of next generation technology (in-memory store, innovative query and visualization) to allow users to consume and analyse data on smart phones and tablets. Other players in this space include Tableau systems and specialist vendors that are purely focused on mobile device visualization such as Roambi.

Exhibit 111: QlikView for iPad



Source: Qlik Technologies.

Exhibit 112: Roambi for iPad and iPhone

Source: Roambi.

> "There were five Exabytes of information created from the dawn of civilization through 2003, but that information is now created every 2 days and the pace of growth is accelerating."
>
> -- Eric Schmidt, Google, August 2010

The growth in data and the collapse in the price of storage, compute power and bandwidth is fuelling amount of data that being created and increased need to manage and analyse this data. The traditional relational database is not optimized for the kind of elastic and distributed environment that big data and cloud computing have created. Many new noSQL databases have been developed over the last couple of years which are non-relational, distributed and horizontally scalable, such as CouchDBm MongoDB, Membase and Redis.

In addition, the frameworks that have been developed by leading Internet companies are increasingly being put to work on general big data problems. MapReduce (which was introduced by Google in 2004) is a framework for processing huge datasets by using a large number of computer nodes to distribute problems. It computes on both structured and unstructured data by mapping (distributing) the input for parallel processing and then reducing (aggregating) the processed data into output files. Similarly, Hadoop, which is derived from MapReduce, handles large files across multiple machines using an optimized distributed file system to manage the data for redundancy and fault tolerance.

Big data also solves for some of the other limitations of traditional databases which struggle with the complexity and poor performance that result from trying to express complex analytics in traditional query languages such as SQL. Big data analysis is changing the rules due to in-database analysis as well as platforms like Aster Data that allow queries to be written in C++, Java, Python, PERL, etc.

A number of large public companies are playing in the big data space, including IBM and EMC (EMC, $22.59, NC). There are a number of other emerging companies that play on the theme of big data, including Cloudera, DataStax and Hadapt.

Apps Stores and Distribution

The traditional channels of retail, resellers and volume distribution have been disrupted for consumer software

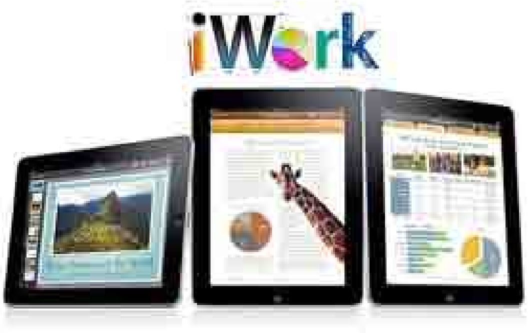
Mobile devices have also disrupted the distribution and pricing of software via app stores. Applications are now bought from walled gardens controlled by the device or operating system vendor who also maintain control over what type of applications are available to purchase. The traditional channels of retail, resellers and volume distribution have been disrupted, at least for consumer software. We would also expect this to impact corporate application distribution as smartphones and especially tablets increase their penetration in that environment.

While Office remains the choice for the enterprise, it is becoming increasingly unclear how Microsoft will be able to sustain pricing on its software even if Windows 8 is successful

App stores have also fundamentally changed the dynamics of pricing, with most applications being priced below $10 and many applications being priced for free for basic or advertising supported functionality. A great example of price compression on new devices is the price of Apple's iWork suite for the iPad compared to Microsoft Office for the PC. The three applications within iWork (Pages, Numbers and Keynote) are sold for $10 each, for a total of $30. This compares to a copy of Microsoft Office Home and Student 2010 (the cheapest available product SKU), which costs $150.

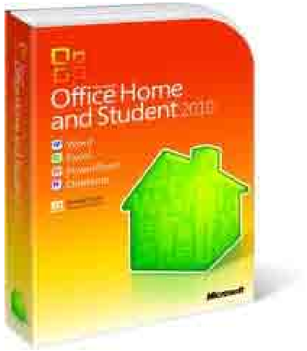
The concept of an app store has also been brought back into the desktop/ laptop world by Apple, which now offers an app store on its Mac platform as well as its iOS platform. Apple is working toward a single operating system (See Peter Misek's note from 8/3/11 on Apple: 'One to Rule Them All: iOS and OX X Roadmaps to Merge') and we expect direct distribution through the App store taking share from other channels across both traditional and mobile devices. *The Wall Street Journal* recently cited Evernote (a popular note-taking application) that has seen a 4X increase in downloads since the App store was introduced onto OS X at the beginning of 2011.

Exhibit 113: iWork for iPAD costs $30 . . .



Source: Apple.

Exhibit 114: ... vs. $150 for the basic version of Office for PC



Source: Microsoft.

Security Moving from Device to Information Protection

With mobile devices now out-shipping PCs, the business models for traditional security vendors is changing, bringing new opportunities and risks. The mobile security market is still in an early stage where many products are still in private or public beta form with many different pricing and distribution models being looked at. Business models for many will change and will likely be a trailing development that takes shape as the opportunity firms.

Similar to how mobility has been first adopted by the consumer and brought about changes in the enterprise, we think the mobile opportunity for security vendors will start in the consumer market before moving into the enterprise. Vendors will look towards a multi-channel distribution approach and we think the focus could shift from device protection and more towards transaction and information protection.

Symantec, as part of its Norton Everywhere initiative, has a number of product initiatives with a strategic approach to surround the device. It will have security offerings on the device, around the device and non-traditional offerings that include information and transaction-based security as well as specific device security such as wipe and clean technologies. McAfee, with its WaveSecure solution, has also expanded its product capabilities to include locate, lock, device clean and limited backup functionalities.

Distribution models will see change and we think the traditional OEM trial-model that has been widely used in the Consumer market will play a much smaller role in the mobile opportunity. Several go-to-market approaches will be trials and / or utilized and include:

Traditional OEM trial distribution. We think this model will see much less interest and traction in the mobile environment. This is due to the easier availability of applications on devices relative to a PC via app stores, the number of device manufacturers and the difficulty of achieving distribution with Apple iOS.

Point-of-sale freeware and service pack options. This approach will likely include basic freeware and could include partnerships with service providers, wireless carriers or retailers rather than device manufacturers; the service providers will utilize these offerings as part of their effort to differentiation their services. This approach would entail a royalty model for the software provider for basic freeware security (i.e., anti-malware) and then an up-sell revenue share agreement for additional functionality such as wipe and clean or location-based security services.

Embedded security. Both Symantec and McAfee will pursue embedded approaches as part of their multi-channel distribution efforts. McAfee's strategy revolves around the integration of its security agent in the Wind River VxWorks operating system; this will expand McAfee's distribution to the 2,000-plus devices that use VxWorks as an embedded OS. Symantec's embedded approach is aligned with its investment and partnership with Mocana. Mocana is in the device security market where it has embedded software in IP-connected devices that work with connected data centers to provide the required security performance within the limitations of an end device.

Non-traditional strategies. Beyond an embedded strategy, we believe mobile security will also entail information and transaction-based security. This is due to the aforementioned differences of OEM-based distribution for devices and PCs, but also because the value is shifting from the device to the information and naturally security will follow. The mobile opportunity will likely evolve along this path as the transaction and connection will become just as important, if not more important, security points than the device itself.

The mobile security opportunity will be targeted by many vendors including share leaders such as McAfee and Symantec but also by smaller private vendors and non-traditional security plays. Our conversations with company managements highlight how early the market is as business plans are very dynamic and will take shape based upon which of the many current initiatives are successful.

Ways to Play Mobility Trends in the Software Sector

Beneficiaries: Salesforece.com, Symantec, Qlik and Telecity are plays on secular growth in mobility

Salesforce.com. Salesforce.com is leveraged to the theme of mobility in three ways: i) Its customer relationship management application focus, which is used by salespeople who often are in the field and who have the most to gain from mobile compute and connectivity; ii) its SaaS business model where the application runs centrally in the cloud and is delivered to users via the browser or through a native application developed for the device; and iii) its social element with Chatter. In fact, the concept of Social, Local and Mobile applications is probably best served in the public enterprise software market by Salesforce.com today.

We also believe that architecture of the platform (Force.com/ Heroku) with its centralized data store in the cloud and open and modern APIs allows developers to easily extend applications written on the platform to mobile devices. This should be a big advantage for CRM (as well as other cloud platform players) in comparison to traditional development infrastructure. The platform already handles 36 billion transactions per quarter and we have high conviction in its ability to scale.

Symantec. Symantec is in the midst of a number of mobile initiatives collectively under its Norton Everywhere campaign. Company management speaks to several different possible types of business models, so there remain a number of unknowns. Our confidence in the company's success in mobile rests with a) the company's market leadership: 47% share in the consumer security market—2.5x its next competitor, according to Gartner; b) growth in devices; and c) consumer's willingness to spend.

We view the mobile opportunity as the next major catalyst for Symantec's business and arguably the first transformative initiative since the Microsoft OneCare release in 2006 which acted to expand the market. We believe the company will look to expand pricing of its solutions to extend coverage to the mobile opportunity which, in our view, would act to reaccelerate growth above the low-single-digit range. In fact, we believe mobile offers the company the first true catalyst in several years to increase pricing.

Qlik Technologies. Qlik's focus on business discovery is leveraged by mobility. QlikView on mobile is a tablet-based BI (business intelligence) experience that allows users to get access to data anywhere, at any time. A number of the key attributes of QLIK are all provisioned through its mobile solution, including interactive analysis, rich visualization and associative search. It uses the paradigm of the tablet for navigation (touch, pinch and zoom) and is served-up in a browser-based approach that allows common access to the same data on the QlikView server from multiple device endpoints such as smartphones and iPads. This notion of access to relevant real-time data from any end point device is clearly a key part of Qlik's message in creating a BI tool that can be used by the masses.

Telecity. Telecity is a European carrier-neutral data center provider with 24 data centers across seven countries. We believe colocation providers are well-positioned to profit from the expected growth in mobile data driven in large part by digital content delivery and cloud-centric applications. Telecity enjoys high utilization rates at its data centers and has, we believe, the management experience to ensure that new capacity additions do not run ahead of demand. Telecity offers an attractive way to play the growth in mobile IP traffic.

Telecity could benefit from accelerating growth due to mobility for a number of reasons: i) the need for distribution of high-bandwidth content and applications. In Europe, an independent mobile software vendor would have to rely on one of the four main carrier-neutral data center providers to achieve this and we think Telecity has a strong platform to fulfill this demand; ii) the network effect of content and application partnerships. We think the ecosystem of partners necessary to synchronise content and applications for a good mobile user experience is something that Telecity already has experience doing; iii) the ability to support real time latency sensitive applications. For example, one area where mobile applications might see significant growth is in financial services applications. To provide the low latency needed by these applications, the back-end systems need to be hosted as close to financial services hubs as possible, particularly in the case of trading exchanges. Telecity has focused on building its data centers in highly central locations such as these.

Adobe and Micro Focus are challenged by secular growth in mobility

Adobe Systems . Adobe prides itself as having a leading position in the multi-screen and mobility world. However, a number of factors have created challenges for the company as it has attempted to make the transition from a focus on traditional PC-based Web creativity tools to those focused on content and application creation for mobile devices. These challenges include: i) the emergence of open standards as an alternative to Adobe Flash for rich interactive media. HTML5 has made Flash less relevant as an output container as many of the features that Flash provides are now supported by the HTML standard within the browser. In addition, cross platform support can be achieved if all mobile browsers support the standard. ii) As a result of less use of Flash, Adobe's scripting language is also being used less. JavaScript has become the user interface development language of choice. This has weakened Adobe's position in mobile development. And iii) the emergence of native development environments such as iOS has also made it more difficult for Adobe to compete on the most popular mobile platforms.

Adobe's effort to become a cross-platform development environment for mobile applications does not appear to have worked. Instead, Adobe is moving to support open standards such that it protects its existing base of creative professionals that use its tools to create content to be used within print, video, photograph, Web and mobile applications. We think this part of the business is relatively resilient due to the size and strength of the user base, although even here Adobe could faces challenges, such as the emergence of the app store concept and downward pressure on application prices.

Micro Focus. Micro Focus is a software vendor that derives roughly two-thirds of its revenue from products that enable software developers to develop, modernize and migrate mostly mainframe-based COBOL solutions to Windows-based client server environments. The COBOL development market is in structural decline, and Micro Focus has been trying to build a testing tools business (the remaining third of group revenue) to reposition itself to a market with structural growth, but which is dominated by market leaders such as HP and IBM.

We think Micro Focus will be marginalized by mobility because: i) mobile applications are not written in COBOL. In a world where SaaS technologies can deliver cloud-based applications to any device by leveraging commoditized hardware (for example virtualized PC farms) and less complex development environments (for example HTML5, Force.com, etc.), the relevance of COBOL and related tools weakens; ii) Micro Focus is late to mobile application testing. Mobile application development has been moving to free or open source platforms, such as Apple Xcode and Android on Eclipse, and there are already well-established testing environments for these platforms; and iii) tool vendors are less important in the cloud. With cloud delivery having arguably become the de facto future, toolkits have become less relevant versus the important decision of choosing the right cloud delivery platform. This is the reason why toolkit vendors such as Microsoft have been focusing more on their infrastructure software, while concurrently making certain development tools available for free.

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How Mobile Will Shape Advertising, Content and Commerce

Executive Summary

- **Penetration of smart phones, tablets and other Web-enabled mobile devices is reaching a critical level in both developed and developing markets, causing marketers, content creators and merchants to sit up and pay attention. At nearly 2.5 billion in 2020, the global smartphone user base will be more than 8x larger than the roughly 300M smartphone users in 2010.**

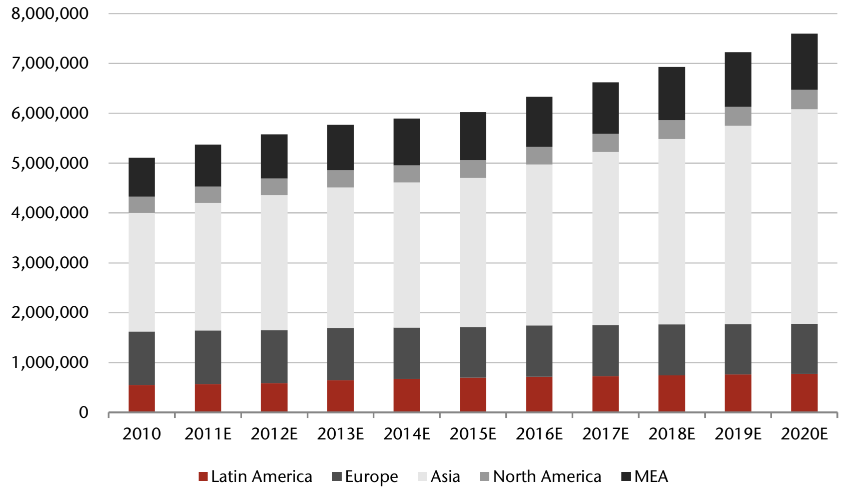
- **Mobile advertising is still nascent, but as the number of users and usage time per device grow, marketers will follow. Mobile is the ultimate mass market ad platform, given its scale, reach, targetability, engagement and analytics.**

- **U.S. mobile ad revenue will hit a major milestone in 2011 as it exceeds the $1B mark for the first time, based on eMarketer estimates, but as a percentage of total digital ad revenue, it's still less than 2%. By 2014, we expect that level to quadruple and by 2020, we believe that mobile will account for the majority of online ad revenue. We see Google and Facebook as two companies particularly well positioned to benefit from this shift.**

- **The explosion of internet-enabled mobile devices empowers consumers to choose how, where, and when to consume content. This has the potential to dramatically change the media landscape, particularly for television broadcasters, the current video gatekeepers. Internet-enabled devices have already affected consumer behavior, with viewers migrating from traditional linear schedules to on-demand viewing. We see this trend as benefitting the likes of Netflix and BSkyB.**

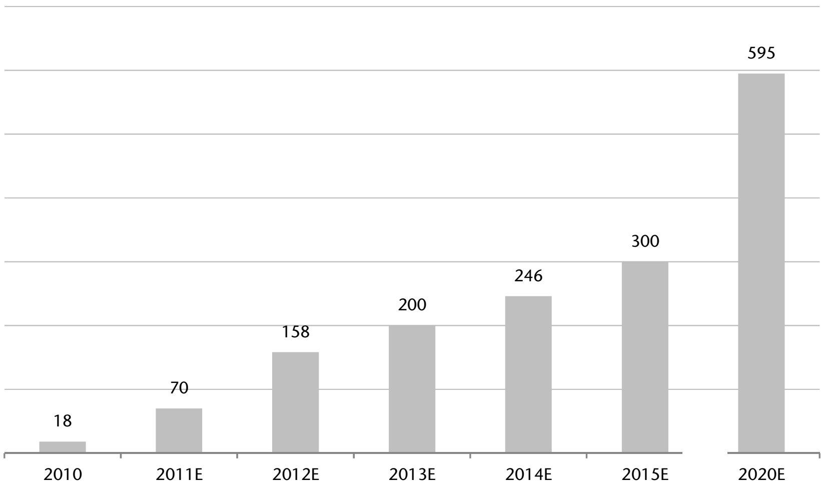
- **While the internet's role in driving local commerce is still nascent today, this is rapidly changing, particularly with the adoption of highly targeted and more efficient models that both consumers and advertisers are embracing. We believe that mobile's growth will play a transformative role in driving local commerce given the ability to target in-market customers on the go via geo-targeted ads, smart e-commerce apps and payments platforms. This shift is likely to play into the hands of companies like Amazon and eBay.**

Exhibit 115: Projected Number of Global Mobile Devices



Source: Jefferies & Co. estimates.

Exhibit 116: Tablets Sold Annually, 2010-2020E (in millions)



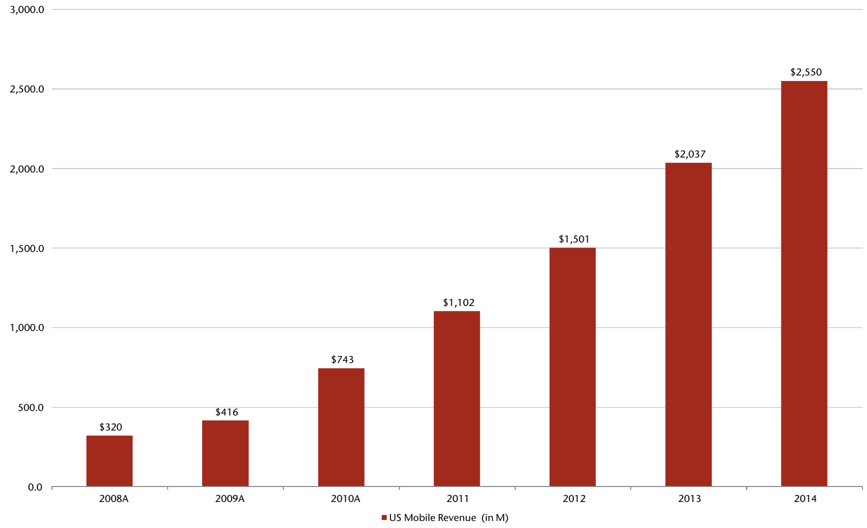
Source: Jefferies & Co. estimates.

How Mobile Will Affect Online Advertising

Mobile advertising is still nascent, but as an ever increasing number of users connect to the Internet on mobile devices, and as their usage grows, advertisers will inevitably follow. Last year, U.S. mobile ad revenue as a percentage of total digital ad revenue was less than 2%; by 2014, we expect that percentage to approximate 8% and, by 2020, it'll likely account for the majority.

U.S. mobile ad revenue was less than 2% of total digital ad revenue in 2010; by 2014, we expect that percentage to quadruple and by 2020, it will likely account for the majority

Exhibit 117: US Mobile Advertising Revenue ($ in M)



Source: eMarketer; Jefferies & Co. estimates.

As mobile devices continue to evolve, there are a few persisting dynamics at work that make advertising on mobile devices very different from traditional desktop and laptop devices:

Reach. Today's mobile devices tend to be more portable and more connected than ever before. Most owners of smartphones, in particular, carry those devices with them wherever they go. They are finding more and more reasons to connect to the Internet, with social media sites like Facebook in particular driving exponential growth in total time spent on the Internet. Therefore, digital advertisers today have enormous reach compared to just a few years ago, when they could only reach people who were sitting in front of their home or work computers. As both online advertising and mobile devices continue to evolve, advertisers will increasingly be able to extend their reach to their target demographic since they will have an increasing number of users to pick from who are connected to the Internet at any given time.

Intent. Since users of mobile devices such as smartphones carry those devices with them wherever they go, they also spend more time connecting to the Internet while they shop at "brick and mortar" locations (using a barcode scanning app to comparison shop, for example). In contrast with researching products to purchase on desktop/laptop devices, consumers that research products on their mobile devices while they shop at brick and mortar stores are signaling a much higher intent to make a purchase and are significantly more likely to convert. Advertisers can more effectively market to consumers if they better understand the consumers' purchasing intentions as well as their influences (such as their social graph, which may show what their friends are buying). We thus expect to see more sophisticated intent-based advertising taking place on mobile devices going forward.

Location. Another important distinguishing element from an advertiser's perspective is the ability to gain insight into a user's current location at a very granular level. Today, the majority of online advertising is done through desktop search and display campaigns, which allow location targeting through a user's login information, as well as the user's IP address. Online advertising search and display campaigns are primarily dominated by middle to larger-sized businesses since they can afford to deploy an online campaign and expect to reach a wide audience. However, local digital advertising has historically mainly been done through email marketing since location-based keywords for paid search (such as "Hardware Stores New York City") are typically too expensive for them. Mobile devices, such as smartphones, will allow local businesses – a huge advertising market – to more prominently market themselves online (on Google maps and other GPS applications for example). Those businesses will be able to target a more granular audience (within a ZIP code, for example) and pay to market only to those customers. GPS maps, in contrast to traditional desktop search, also expand the real estate upon which ads can be deployed.

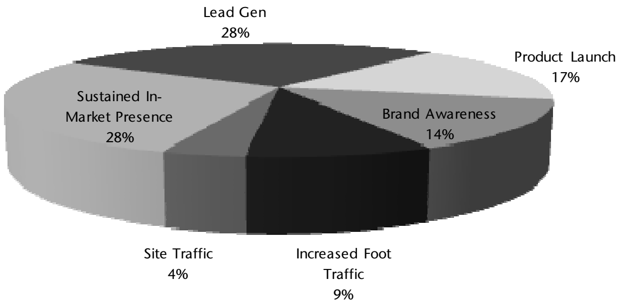
Behavioral Tracking. While behavioral tracking is not unique to mobile, mobile devices provide another dimension of user behavior information by tracking user locations. Mobile phones (operating systems and certain applications) are constantly tracking users' locations, providing advertisers greater insight (privacy concerns aside) into what stores users are visiting on a regular basis. Also, with the advent of mobile-based social media trends such as "checking in," users are freely advertising their own location/behavior to their entire social-graph (and consequently to advertisers). For example, an advertiser could try to measure the effectiveness of a branded ad campaign online by tracking how many of those users end up in stores afterwards.

Challenges remain with an immature mobile infrastructure and fragmentation across devices, platforms and apps

Challenges

One of the challenges of advertising on mobile devices is that the infrastructure is still immature and fragmented. On smartphones, screens are small and most ads are not optimized for mobile delivery. For example, how does an advertiser know if a display ad impression is delivered on a smartphone screen if a user lands on the right webpage but does not scroll to the area on the screen where the ad is visible? Mobile devices also operate on multiple platforms such as different versions of Android, Honeycomb, iOS for iPhones and iPads, Windows Phone, etc., further complicating the ad serving process. Additionally, a vast majority of websites are still not optimized for HTML5 or browsing through tablet devices. As a result, it is difficult to manage mobile campaigns and measure their effectiveness across various platforms/devices. Another phenomenon around mobile advertising is that mobile device users are increasingly connecting to Web sites through applications, thereby circumventing the traditional browser experience. This also increases the complexity of managing ad campaigns, app developers/publishers and ad serving technology alongside the right user experience.

Exhibit 118: Advertiser Campaign Goals



Source: Millennial Media 2Q11 S.M.A.R.T. Report.

Exhibit 119: Top 10 US Ad Verticals

1	Retail & Restaurants
2	Telecomm.
3	Finance
4	Entertain.
5	Auto.
6	Travel
7	Dating
8	CPG
9	Portals/Directories
10	Pharma

Source: Millennial Media 2Q11 S.M.A.R.T. Report.

When, Where and How Consumers Want It: Content Is Becoming Ubiquitous

Mobile devices are changing how we consume content: when, where, and how we want it

The explosion of Internet-enabled mobile devices empowers consumers to choose how, where, and when to consume content. This, in our view, has the potential to dramatically change the media landscape going forward, particularly for television broadcasters, the current video gatekeepers. Internet-enabled devices have already affected consumer behavior, with viewers migrating from traditional linear schedules to on-demand viewing.

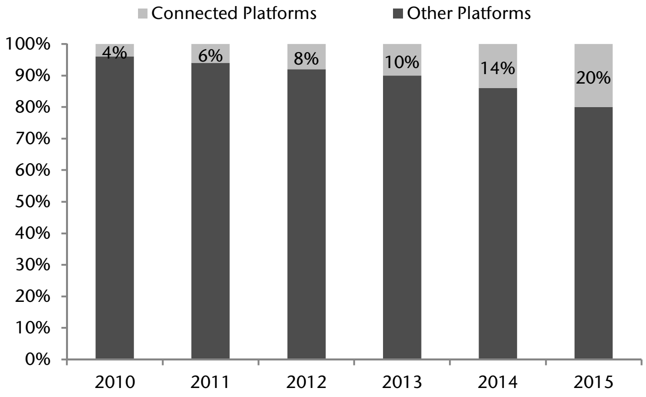
In the UK, for example, the BBC iPlayer (an online viewing platform with archived content) has seen 30% annual growth – but PCs still account for 75% of views. As the cost of mobile devices falls, consumers will be able to cut ties to their PCs and watch on the go. As a result, we see the new wave of mobile device adoption accelerating change within media consumption with potentially profound implications for legacy broadcasters who, in our view, have been slow to adapt to and react to technological change. At the very least, it creates a more fragmented environment as new platform operators and content producers compete for TV viewers.

While we view the changing landscape as challenging for legacy broadcasters, we see ITV (ITV LN, 61.25p, Hold) as best positioned given current management initiatives to increase online monetization. Beyond some mini-pay subscriptions, the group is yet to provide much detail on how the new model will work but they are at least addressing the issue unlike some of their continental European peers, particularly Antena3 (A3TV SM, €4.93, Underperform) which is preoccupied trying to find a partner to merge with to cope with the difficult macroeconomic environment and its much larger competitor, Mediaset Espana (TL5 SM, €5.04, Buy).

In the UK, we see the biggest beneficiary of this change in user behavior as BSkyB. BSkyB collects a significant amount of customer data and owns the set top box most connected TVs are wired to. With set top boxes connected to the Internet, custom ads can be broadcast that are dependent on the demographics of each household, thus creating targeted advertising and potentially higher prices. As gatekeepers for this information, Sky holds a significant amount of power.

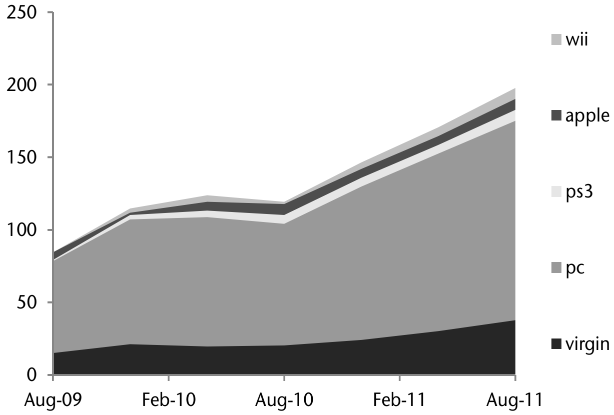
While these challenges for broadcasters remain on the horizon, we see no signs of the current trend to ubiquitous content consumption slowing. Redshift, a media technology consultancy based in London, forecasts that 20% of television viewing will be on Internet-enabled devices by 2015 versus 4% in 2010, mainly as a result of the continued proliferation of devices.

Exhibit 120: UK Internet Connected Devices (% Share of Viewing)



Source: Redshift Consulting.

Exhibit 121: BBC iPlayer Total Views by Platform

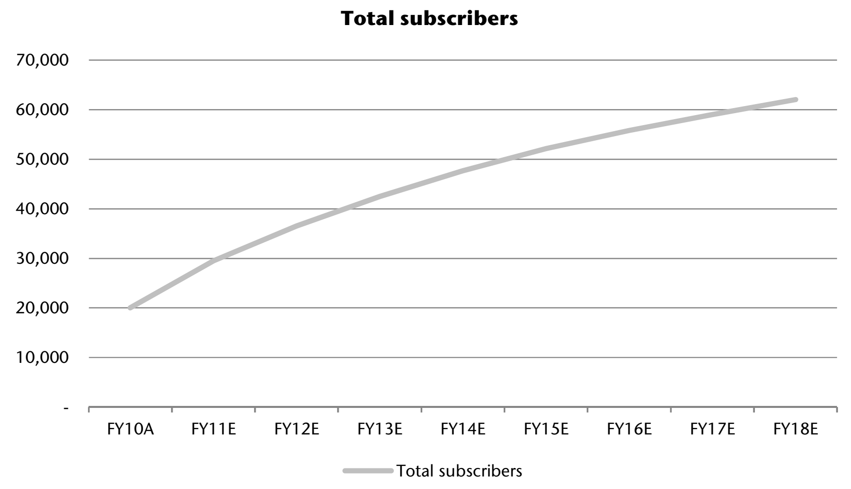


Source: Redshift Consulting.

Netflix has created a great value proposition for consumers of content, when where and how they want it, while revaluing its worth for the studios

In the US, Netflix was the first to stream high quality professionally produced content to TVs, computers and mobile devices. Streaming into the living room was propelled by establishing agreements with consumer electronics partners, such as connected Blu-ray players and videogame consoles, and mobile devices followed shortly thereafter with the iOS and Android apps. The rapid adoption of streaming is best captured in Netflix recent subscriber guidance: In 3Q11, Netflix expects 40% of ending subscribers to have streaming-only plans (10M subscribers), or 88% streaming penetration when including hybrid streaming/DVD plans (22M subscribers). By 2020, we expect 100% streaming penetration on nearly 70M ending subscribers, globally.

Exhibit 122: Netflix Subscriber Growth Estimates (in 000s)



Source: Jefferies & Co. estimates.

Media Consumption is Moving From One-to-Many to One-to-One

Mobile allows for more targeted and relevant advertising, disrupting the traditional broadcast model

Given the plethora of choices available for consumers, we expect the typical broadcasting model (one-to-many) to evolve into more of a one-to-one, interactive experience. The switchover from analog broadcasting to digital provided customers with the choice of "what" to watch, and now the rise of mobility gives the additional choices of "how" and "where." Consequently, we see the risk of further audience fragmentation, a disruption to the business models of legacy media companies (and particularly broadcasters) as their unique selling point remains mass audience reach. However, the one-to-one experience does hold the potential to lift overall advertising spend as it allows for better targeting to individual households based on factors such as viewing behavior and location. BSkyB, the largest pay TV platform in the UK, for example, is expected to launch its "AdSmart" system which will enable advertisers to target ads to about four million household postcodes. Indeed, targeting may allow media companies to capture some share of direct marketing advertising spend, and eventually allow an accurate audience measurement system. However, it is our view that this will take a few years to implement given the proliferation of devices, and the broadcasters may not be in a strong position to negotiate a share of the upside with the platform operators.

Online video is the fastest growing online ad format, with the number of videos growing 600% and ad spend growing 344% over the last five years. In 2010, $1,440M of ad spend was generated and 441B videos were played, according to comScore. The top Web properties for content videos are provided in the table below.

Exhibit 123: Content Video Viewership – June 2011

Web Property	Total Unique Viewers (000)
Google Sites	149,281
VEVO	63,003
Yahoo! Sites	52,665
Microsoft Sites	50,663
Viacom Digital	49,493
Facebook.com	47,687
AOL, Inc.	43,915
Turner Digital	30,063
Hulu	26,701
NBC Universal	19,602

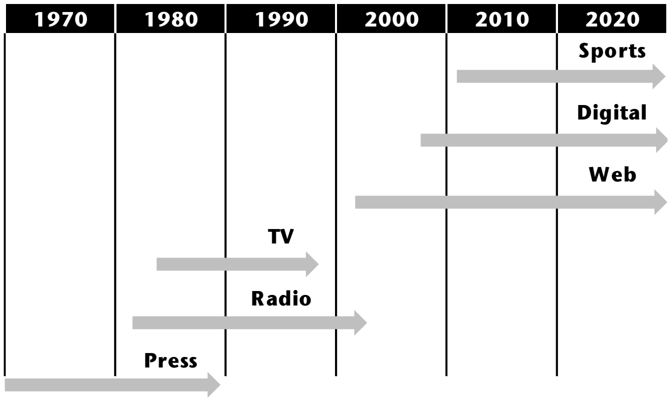
Source: comScore.

Content Is King – Particularly Sports and Live Programming

Professionally produced content is and will remain king for a long time to come

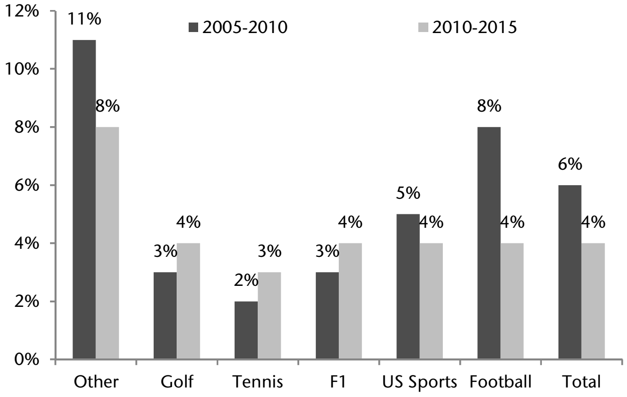
Despite audience fragmentation and falling barriers to entry for content creation (YouTube), consumers still crave professionally produced content. However, this content is becoming increasingly difficult to monetize especially as end users trend to on-demand formats, usually with fewer commercial interruptions or the ability to skip them altogether. In large part to maintain their aforementioned unique selling point of delivering mass audiences, broadcasters are increasingly turning to sports and popular interactive and live formats (*American Idol, X-Factor*, etc.). These shows force consumers to either watch live or avoid news sources and social media – an increasingly difficult order in today's wired world. However, third-party content providers that own the formats or sports distributions rights are well aware of this and consequently increase prices. For example, the International Olympic Committee has raised prices 50% over the last decade for distribution rights, well ahead of inflation. The trend is expected to continue. Lagadere, for example, expects the global sports rights market to grow 4% per year through 2015 to reach €68.3b. The steep increases have eaten into returns for traditional media players and broadcasters have yet to put a solution forward to curb inflation and are likely to continue to be reliant on big budget productions.

Exhibit 124: Engines of Media Growth



Source: Lagadere.

Exhibit 125: Sports Content Performance by Type



Source: Lagadere.

Content licensing/distribution deals are playing catch-up with mobile tech, but coming online quickly

Content is rapidly migrating to mobile devices

By 2020, we expect nearly all content to be available on mobile devices, since by this time content owners (such as Disney, CBS and News Corp), traditional content distributors (i.e., cable MSOs such as Comcast), and Internet models (Netflix, Hulu, and Amazon Prime) will have worked through the separation of traditional and streaming content rights. Legacy content deals should expire over the next three to five years, upon which time traditional and streaming content distribution rights go to the highest bidder. Netflix was the first to strike up meaningful streaming content deals with Hollywood studios and TV production companies (the $1 billion, five year deal with Epix in August 2010 comes to mind), in many cases offering value for older catalog content that wasn't doing much for the content owners. More recently, in 2Q11, Netflix struck streaming agreements with Miramax and Revolution Studios, announced a multi-year deal with Open Road Films, and the first films from a deal with Relativity Media are becoming available. Going forward, increased competition and more interested players should continue to increase the selection of streaming content available to consumers on multiple devices.

The Social Framework Will Become Increasingly Important for Content over Time

The social layer is increasingly important for connecting users with content. Over time, it will also play an important role in influencing content, tastes and preferences

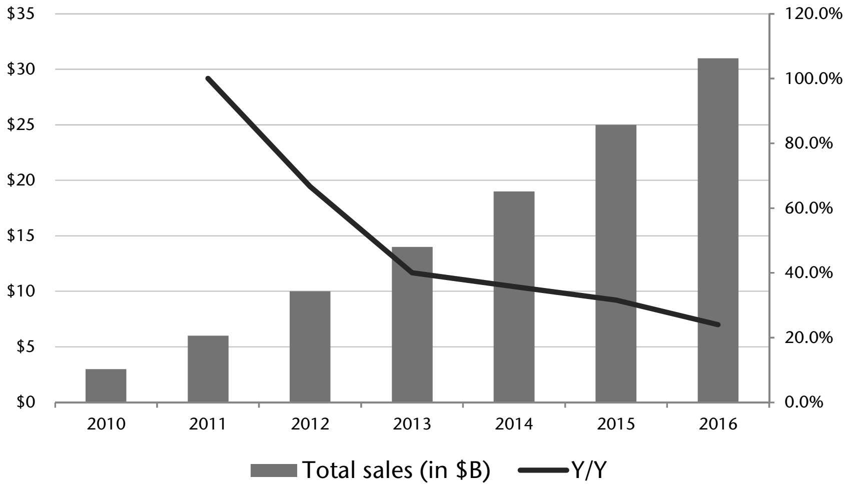
Content in 2020 will not only be available when, where and how consumers want it, but it will also include social integration, such that users can view recommendations from friends, post comments, or view a friend's film collection. Netflix doesn't have a functional social integration with Facebook yet, but the company is making significant progress, with an expected launch scheduled before the company's next earnings report. Similarly, traditional media companies also see the potential from integrating core content with a social fabric. Time Warner's (TWX, $31.66, NC) announcement to acquire Flixster (including the "Rotten Tomatoes" website) is expected to provide a consumer interface for Time Warner's content and the social framework needed to compete and drive further interest in core film and TV content.

Mobile's growth will play a transformative role in driving local commerce given the ability to target in-market customers on the go via geo-targeted ads and "smart" e-commerce and payments apps

Mobile's Impact on eCommerce and Local Commerce

While the Internet's role in driving local commerce is still in relatively early stages today, this is rapidly changing, with the adoption of mobile devices and emergence of new, highly targeted and more efficient models that both consumers and advertisers are embracing. We believe that mobile's growth will play a transformative role in driving local commerce given the ability to target in-market customers on the go via geo-targeted ads and "smart" e-commerce and payments apps.

Exhibit 126: Mobile Ecommerce Sales



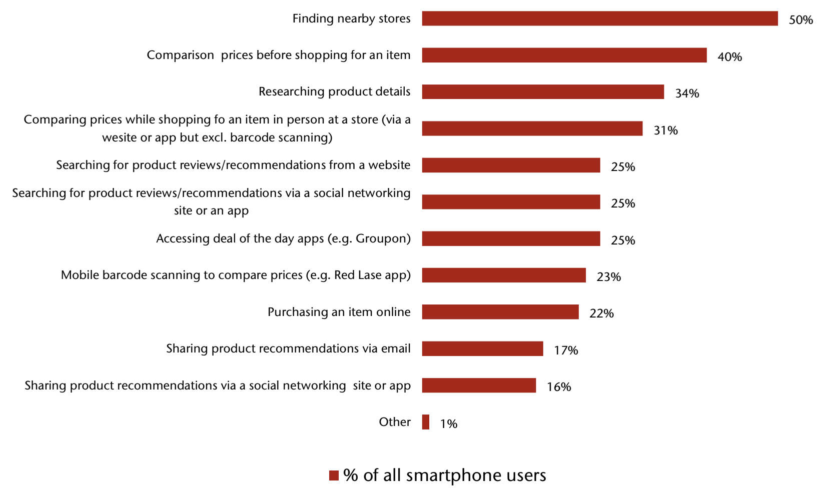
Source: Forrester Research.

The exponential growth in the smartphone and tablet installed base, supported by high downloads speeds (4G, 3G), will help drive up the volume of e-commerce transactions conducted over mobile devices. At an expected 2.5 billion in 2020, the global smartphone user base will be more than 8x larger than the roughly 300M smartphone users in 2010 by our estimates. Over this same period, the tablet market should grow to nearly 600 million, a 33x increase from 18 million last year.

The ubiquity of smartphone/tablet-based apps such as Red Laser, eBay and Amazon will help power in-store comparison shopping, which should drive growth in ecommerce. Mobile's growth will benefit traditional retailers as well, with GPS enabled mobile devices enabling discovery of in-store inventory (through apps such as Milo) as well as via the delivery of targeted promotional offers, which will help drive foot traffic to store locations.

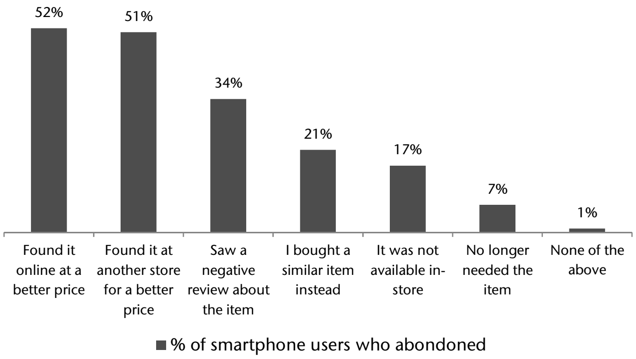
A survey of smartphone users demonstrated (Exhibit 127 below) that a majority are already using them for shopping. This shift in consumer behavior is likely to continue at an accelerated pace, driven by higher merchant participation, better/"smarter" apps and improvement in user interface, along with greater penetration of tablet devices.

Exhibit 127: Smartphone Usage for Shopping



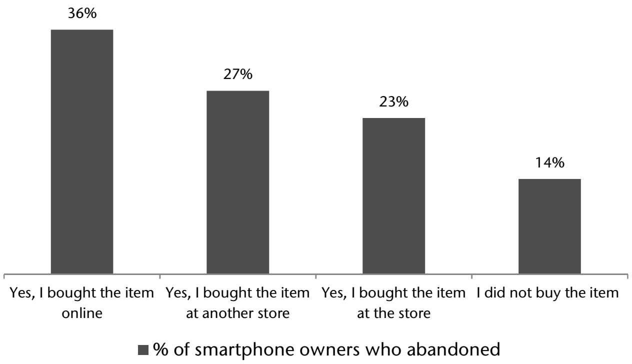
Source: comScore.

Exhibit 128: In-store Purchase Abandonment



Source: comScore.

Exhibit 129: Reasons for In-store Purchase Abandonment



Source: comScore.

The availability of geo-targeted information is enabling customers to find the nearest movie theatres, restaurants and other businesses via mobile devices. Wireless mobile devices will not only support online payments but will support point of sale payment through NFC and other technologies (see Jason Kupferberg's analysis later in this report).

"Daily deal" services such as Groupon and Living Social, which are credited with creating the nascent but fast growing market for local deals, are already targeting audiences through mobile apps. We expect the growth in the mobile user base to lead to increased participation by local businesses in the online channel for promotions, which should further increase the quality of the online offering. We also expect non-U.S. markets to be a major growth driver given that the size of the addressable opportunity in retail (including foodservice, entertainment and travel) is an estimates $17.5 trillion outside of the U.S. versus $4 trillion within the United States.

Mobile's Impact on Online Travel

We believe that the travel sub-segment is likely to see major growth in mobile bookings, given that mobile apps enable customers to do travel planning on the go, track flight status and make/amend flight and hotel reservations. Indeed, large online travel companies such as Expedia and Orbitz have noted the traction they've seen with their mobile applications. In addition, we believe destination research sites (such as TripAdvisor) will also experience a shift in traffic to mobile. In our view, the near ubiquitous availability of travel planning/booking tools via mobile devices will enable online travel companies to go deeper into the travel funnel and book more local leisure activities (think of offers for paragliding in Key West, bike rentals in San Francisco, or discounted show tickets in New York). We view such a trend positively for Expedia (EXPE, $30.31, Buy) and Orbitz (OWW, $2.54, Hold).

Cloud Services and Platforms to be a Key Beneficiary of the Growth in Mobile

Cloud services offer the next big growth opportunity on the Internet today due to both cost advantages and convenience

The embrace of wireless devices will, over time, lower the need to carry around data locally, as we believe most of the online services will evolve around cloud-based solutions. Besides the obvious benefits of having more robust cloud-based offering which can be accessed seamlessly by the consumer, storing customer data in the cloud also allows companies to create stickier offerings. E-books and music purchased via Apple's iTunes and Amazon, Netflix's streaming video and Pandora radio are examples of such services today. We expect cloud-based service providers such as Google and Amazon to be prime beneficiaries of this trend.

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How Payment Systems May Be Rethought, As Mobile Platforms and Applications Change

Executive Summary

- **Mobile payments at the physical point-of-sale (as opposed to mobile ecommerce purchases or peer-to-peer payments) remain the largest potential long-term mobile commerce opportunity by a significant margin, we believe. In the foreseeable future, we see this opportunity as more significant in less mature economies.**

- **While there is currently very little non-pilot/non-experimental mobile POS payments volume being generated, key industry players seem to be settling on near field communications (NFC), as the primary means by which a mobile payments-enabled phone will communicate with a retailer's POS hardware/software.**

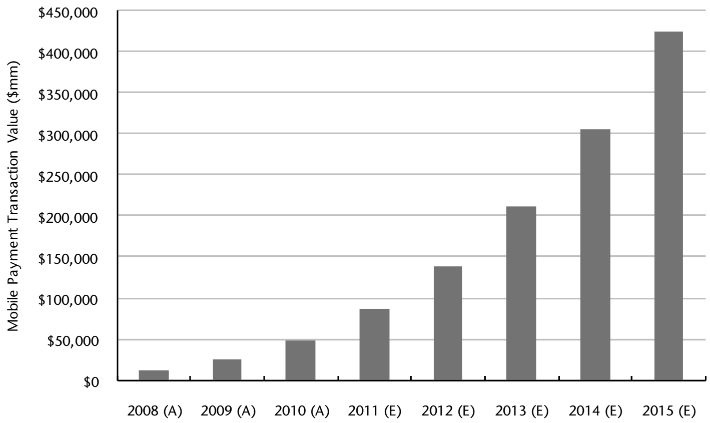
- **A key recent development is the market entry of powerful players who are not primarily focused on capturing transaction fee revenues per se, but rather on leveraging mobile POS payments to extend existing, lucrative e-commerce business lines into a bricks-and-mortar retail environment (i.e., Google, Amazon, etc.).**

- **We believe a key driver of widespread mobile payments adoption in the U.S. is dynamic mobile marketing/advertising, and that a simple change in payments form factor (i.e., from card to phone) will likely not resonate with either consumers or merchants.**

- **We do not expect traditional card networks such as V and MA to be disintermediated by mobile payments. Both have continued to actively invest in this space for years, and to the extent consumer/merchant adoption of this channel increases over time, we would expect V and MA to benefit.**

- **Gartner predicts rapid growth in mobile payments, with the estimated value of global mobile transactions totalling $424 billion in 2015, up from $49 billion last year and representing future CAGR of 54% (see Exhibit 130):**

Exhibit 130: Global Mobile Payments Volume Growth (2008-2015E; $ in millions)



Source: Gartner.

Note: Includes the following transaction types: merchandise purchases, ticketing, money transfers, bill payments, and prepaid mobile phone top-ups.

Few sectors in the payments industry have received more attention recently than mobile payments. There is good reason for this: while it is premature to show with certainty how the various technology options and proposed business models will eventually combine to form a widely-adopted mobile payments solution, most seem to agree that the ubiquity of mobile devices, coupled with the increasing popularity of Internet-connected smart phones (as discussed elsewhere in this report), will lead to an important role for the mobile channel in the future of payments.

We believe that this is likely a fair assessment, though we caution that despite significant progress overcoming technological/business model-related hurdles, the industry has yet to identify a compelling consumer or merchant value proposition for many key mobile payments segments (such as payments at the physical retail point of sale, for example). As a result, the "chicken and egg" challenge remains significant in the mobile payments market, especially within the U.S., we believe. We therefore believe that the mobile payments adoption curve at the point of sale in mature/developed economies such as the U.S. will likely be less steep in the next three to five years than some more bullish industry stakeholders would prefer. In addition, we generally disagree with the view that payments industry incumbents such as V and MA face serious potential threats from competitors in the mobile space. As we discuss later in this section, we believe V and MA will more likely realize a net benefit from future growth of the mobile payments channel.

The recently announced mobile payments partnership by Google is interesting—Google is not seeking to capture revenue from the mobile payment transaction itself, but rather from commissions paid by merchants that put their offers in Google Wallet

Open questions surrounding mobile payments at the POS include: 1) how quickly consumers will adopt smartphones with embedded NFC chips (assuming that will be the preferred technology for mobile payments), 2) who will pay for upgrades of merchant terminals, and 3) how economics will be shared among various players in the value chain, such as the telco carriers and handset manufacturers, in addition to the traditional participants (i.e., banks and networks). For this reason, we find the recently announced mobile payments partnership led by Google to be particularly interesting. It appears that Google is not seeking to capture revenue from the mobile payment transaction itself, but rather from merchant commissions who put their coupons/offers in Google Wallet. It remains to be seen how long it will take to more broadly expand the group of banks, networks, and merchants participating in Google Wallet. And right now, consumers must have a Samsung Nexus S smartphone and a Citibank/MasterCard account to use Google Wallet (or they can use a Google prepaid account). We do not believe that Visa currently has plans to join the Google program.

We simply don't expect traditional card networks such as V and MA to be disintermediated by mobile payments – both have continued to actively invest in this space for years, and to the extent consumer/merchant adoption of this channel increases over time, we would expect V and MA to benefit. Isis (the JV announced in 2010 including numerous telcos, Barclaycard, and Discover) initially seemed on the surface like a potential threat to V and MA, but so far both consumer and merchant reception seem quite lukewarm, and we believe Isis' value proposition has also been negatively impacted by the Durbin Amendment, which will likely erode any significant amount of price advantage that Isis may have had vs. the traditional V/MA model, because new debit card fee caps are likely to significantly reduce the spread between Isis' merchant pricing vs. what the incumbent bank card schemes charge. V and MA both announced in July 2011 that they are joining the ISIS consortium, as we believe Isis has come to realize that an open approach to mobile wallets is necessary.

Key segments

The term "mobile payments" is a catchall for multiple categories of mobile-based transactions. We consider the following to be the most important transaction types:

- **Mobile point-of-sale (POS) mobile payments**
- **Peer-to-peer (P2P) money transfers**
- **Mobile e-commerce**
- **Mobile acceptance**

Mobile POS payments

Mobile payments at the physical point-of-sale remain the largest mobile commerce opportunity

Payments at the physical point-of-sale remain the largest potential long-term mobile commerce opportunity by a significant margin, we believe. However, we also see this as probably the most complex and challenging mobile payments sub-segment due to the large number of value chain participants (e.g., telcos, handset manufacturers, payment networks, banks, merchants, POS terminal manufacturers) required to agree on business strategy, infrastructure development, and revenue sharing in order to make mobile POS payments an attractive service to consumers, who we believe are generally satisfied with the status quo of the traditional card-based payment system.

Near Field Communication (NFC) technology is in the lead

Industry players settling on near field communications (NFC), as opposed to SMS text messaging, for Mobile POS payments

While there is currently very little non-pilot/non-experimental mobile POS payments volume being generated, some limited aspects of a standard technological architecture are gradually coming into focus. Key industry players seem to be settling on near field communications (NFC), as opposed to SMS text messaging, as the primary means by which a mobile payments-enabled phone communicates with a retailer's POS hardware/software.

Near-field communication works through magnetic induction between two antennas when placed in close proximity to each other (typically a distance of 1 inch or so). The subtle difference between near-field vs. contactless communications is that NFC requires both antennas to be powered, whereas with contactless (i.e., a MasterCard PayPass-enabled card), only the card terminal is powered, while the antennae embedded in the plastic is an unpowered filament.

While payment networks, banks, and telcos have piloted various mobile solutions, POS hardware manufacturers (e.g., Verifone [PAY, $35.22, NC]), wireless carriers (e.g., Sprint and the Isis consortium), wireless operating system developers (i.e., Apple with the iPhone's OS, Google with Android, Research in Motion [RIMM, $32.49, Hold] with the Blackberry's OS, and Microsoft with mobile Windows), as well as mobile wireless handset manufacturers (e.g., Samsung, Nokia, Apple) are all increasingly on the same page about integrating NFC capability/compatibility into their respective products.

For example PAY (the largest U.S. manufacturer of countertop POS terminals, claiming 60%+ of US market share) has for some time offered a NFC module, compatible with existing lines of countertop card terminals. The company has indicated that its latest VX evolution line—and all other future product lines—will come standard with NFC capability. Admittedly, POS hardware replacement cycles are long, with some merchants opting not to regularly replace dated POS equipment. At some point, however, as the replacement cycle turns (which we estimate to be approximately 7 years long), standard integration of NFC technology into POS hardware may result in widely distributed NFC capabilities at the point of sale. Verifone has indicated that key large national chain retailer customers have already requested NFC capability.

Likewise, we view Visa's recently announced EMV roadmap (designed to encourage merchants to rollout EMV- and NFC-compatible POS equipment) as going some part of the distance to answering the question of who is going to pay to upgrade POS hardware to accommodate mobile NFC transactions. V is allowing US merchants who process 75% of their total transaction volume over EMV/NFC-enabled terminals to forego costly PCI (Payment Card Industry security standards) compliance. We believe that this is a potentially valuable carrot for merchants, as ensuring PCI compliance is quite costly, and therefore may encourage some merchants to exchange onerous PCI compliance-related costs for a one-time investment in NFC/EMV POS equipment.

We also believe that wireless handset manufacturers have had the capability to install NFC for some time (e.g., Nokia's 3220 model from 2005), but were waiting on their telco customers to request that the technology be included. In this sense, and independent of its commercial prospects, Isis may prove to be a large boon to the entire NFC-based mobile payments ecosystem, as the carriers involved in the Isis consortium (as well as Sprint, who opted not to participate) have given the green light to some of their handset-manufacturing partners to integrate NFC technology, we believe.

According to ISuppli, shipments of NFC-enabled devices are projected to increase from 93.2 million handsets in 2010 to 544.7 million in 2015

For these reasons, we believe that NFC functionality will eventually be found on most smartphones. According to the market research firm ISuppli, shipments of NFC enabled devices are projected to increase from 93.2 million handsets in 2010 to 544.7 million in 2015.

Mobile POS payments architecture: OpenNFC could change the equation

NFC-based mobile payments rely heavily on two elements in the phone: 1) the actual NFC "radio" that communicates with the point of sale equipment (via the ISO 14443 standard) when a transaction is made, and 2) the "secure element" which is basically the place where the digital ID (or "mobile wallet") of the mobile payer (i.e., consumer) is stored. There are four possible locations for this secure element: on a flash memory card (e.g., Micro SD) that can be inserted into the phone; 2) on an external apparatus attached to the phone (e.g., Visa's plastic NFC iPhone case, or an RFID sticker); 3) embedded in the core circuit of the handset itself; or 4) on the SIM card.

In our view, the most elegant solution is to have the secure element on either a chip embedded in the phone, or on the SIM. Otherwise, the consumer is required to either insert a memory card (i.e., micro SD) into the phone to enable NFC mobile POS payments, or affix an external RFID sticker/peripheral.

Until recently, the provisioning of the secure element was essentially dominated by the telco carriers, who would, during the activation process, install (or have a third-party install) all the applications that were going to use the radio. Locked out of "owning" the secure element (and therefore the customer), other non-telco players such as V, MA, Google, PayPal could only experiment with external RFID stickers, NFC enabled plastic external peripherals, Micro SD flash memory cards, etc, in hopes that they could bypass the telco's control with relatively cumbersome solutions. These non-telco players had no choice but to attempt to circumvent the handset's originally provisioned payment application, as they lacked a method of installing their own application onto the phone, one that would allow them, instead of the telcos alone, to make use of the NFC radio.

Recently developed Open NFC architecture/protocol has the potential to this change this situation, in our opinion. Open NFC is open source, commercial-grade middleware for mobile phones that allows a device's operating system (e.g., Google Android 2.3, or Windows WIN/CE Mobile, etc.) to control the radio within the mobile device. The commercialized version of Open NFC includes software libraries and, most important, application program interfaces (API), that are essentially protocols/tools allowing third-parties to create applications that reside on the phone and control the radio via the phone's operating system.

The idea is that a mobile POS payments application that controls the radio can be installed at any time on the phone, rather than provisioned only by the telcos/MNOs. All of this has the effect of enabling third parties such as Visa, MasterCard, Google, PayPal, and Amazon, among others, to implement the elegant solution of provisioning an embedded secure element remotely, while at the same time taking ownership of the mobile payer's credentials and corresponding data. Crucially, for consumers this provisioning of the secure element would be seamless and not require any other effort on their part other than downloading a smart phone app.

Open NFC has potentially boosted the prospects of non-telcos (such as Visa, MasterCard, Google, and Paypal) who can now partner directly with handset manufacturers to bypass the carriers and control the end user's payment credentials/data

Open NFC has already begun to change the rapidly developing mobile payments playing field, we believe. The telcos/MNOs wanted to solve the problem of limited interoperability (meaning one telco's mobile POS payments solution not working on a competitor's platform) by creating a consortium (namely Isis) that would preserve a closed, telco-controlled architecture, exclusively for the customers belonging to the consortium's members (i.e., subscribers of Verizon Wireless, AT&T Wireless/T-Mobile). Open NFC has changed this dynamic, potentially boosting the prospects of non-telco's who can now partner directly with handset manufacturers to bypass the carriers, while simultaneously deflating the business case of the Isis consortium, who built its business case with the assumption that they would continue to control the secure element, and therefore own each customer's credentials and transaction data, etc.

While the telcos could respond by refusing to subsidize handsets that are capable of being provisioned remotely by other parties (e.g., Google, Apple, etc.), they risk a negative reaction in the marketplace if they fail to provide services that become, at some point in the future, in high demand by consumers, such as mobile payments, or more likely, the mobile marketing/targeted offers/comparison tools beginning to be offered by players such as Google and PayPal. We further believe that competition among telco carriers will facilitate adoption of OpenNFC technology. For example, Sprint (not a member of the Isis consortium) is the carrier involved in the Google/MasterCard pilot, which employs OpenNFC architecture via the Samsung Nexus S handset. If the Google Wallet offers that are central to the pilot strike a chord with consumers, other carriers might have to accommodate the new technology as well or risk losing market share to Sprint.

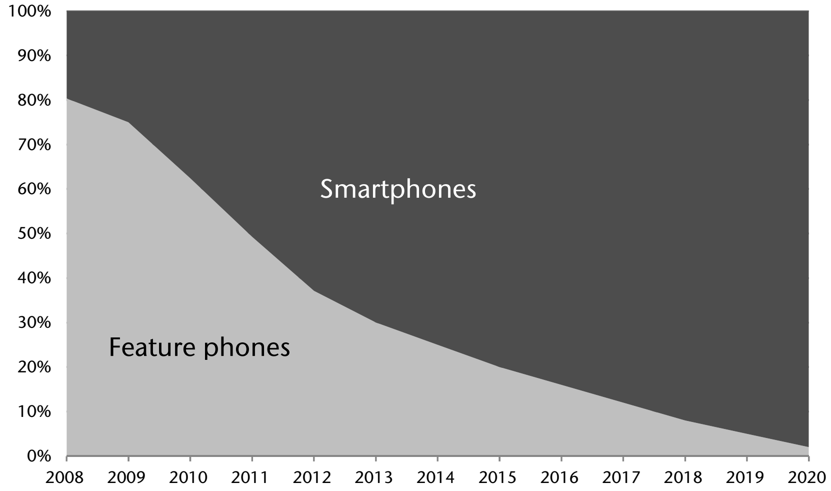
Key players: many paths, many goals

The current lack of a compelling mobile payments value proposition for consumers and merchants (in developed economies) is directly related to the success and widespread penetration of existing (primarily card-based) electronic payment methods, we believe. For this reason, industry participants are finding that just introducing mobile as a new way to pay may not be enough to get a significant percentage of consumers to switch from using credit/debit cards to making payments with their mobile phones.

We believe that a key development across many mobile POS payments programs is the recognition that the unique attributes of mobile marketing may prove crucial in driving both consumer and merchant adoption of the technology. The increasing power and capabilities of smart phones look set to enable retailers and other industry participants to enhance the physical shopping experience by leveraging mobile communications to create next-generation, customized loyalty programs that might deliver in-store coupons, bar-code product look ups, product reviews, demonstration videos, and potentially even in-aisle purchasing. For example, after walking into a Target (TGT, $51.67, Hold), a consumer who previously purchased gardening items might receive an offer to save $10 on an additional $100 purchase from the gardening department if the mobile device is used for payment. Likewise, retailers could potentially leverage the mobile channel to match offers for high-margin or overstocked products with consumers whose previous purchase history might indicate an increased propensity to act on those offers and buy those products.

While in the past, the limited number of smart phones in consumers' hands may have hindered development of more innovative mobile marketing programs, this appears to no longer be the case. Smartphones are forecast to comprise 50%+ of North American mobile devices by the end of 2011 (see chart below).

Exhibit 131: North American smartphone penetration (2008-2020E)



Source: Jefferies & Company estimates.

Powerful players entering the market are primarily interested in leveraging mobile POS payments to extend existing, lucrative e-commerce business lines into a bricks-and-mortar retail environment

Perhaps a more important industry development is the market entry of powerful players not primarily focused on capturing transaction fee revenues per se, but rather on leveraging mobile POS payments to extend existing, lucrative advertising-driven e-commerce business lines into a bricks-and-mortar retail environment. For example, we believe that Google, Amazon, and (to a lesser extent) Apple are all evaluating mobile POS payments strategies whose primary revenue streams may be derived from items such as targeted ads/discount offers, or driving retail customers to make online purchases while still in-store, rather than from transaction fees.

We note however, that an actual mobile payments capability is likely the only way that players focused on targeted ads/marketing can prove the worth of their programs to merchants, and accurately link specific marketing offers to specific purchases (i.e., analogous to click-through or purchase metrics collected in the context of Internet targeted ads). For this reason, even players that may not be primarily interested in capturing transaction-based fee revenue are nonetheless getting into the mobile POS payments business, as a means to an end of capturing advertising-driven economics.

The section that follows presents a summary of Mobile POS payments strategies and key developments for a handful of key industry participants (V and MA are discussed in a separate section that immediately follows):

- **Amazon**
- **PayPal**
- **Google**
- **Apple**
- **Isis**
- **American Express**
- **Research in Motion**

Amazon

Goal: Increase mobile sales on company website

We believe that Amazon is well positioned to utilize the mobile channel to drive significant customer traffic from offline retailers to the company's website. Amazon does not appear to be primarily interested in POS payments per se, but already possesses the infrastructure to provide shoppers with price comparison and fulfillment options when at retail. Amazon already has mobile bar code scanning, picture recognition, and product search capabilities. Amazon's mobile commerce opportunity occurs prior to checkout, which is why we believe AMZN may be currently deciding whether or not to roll out an NFC-based mobile POS payments solution, but that they view the solution largely as a defensive measure to ensure continued access to mobile consumers at retail.

PayPal

Goal: Capture transaction-based revenues

PayPal has is now processing nearly $6 million in mobile transactions per day, and forecasts total mobile payment volume of $2 billion in 2011 (vs. just $24 million in 2008)

PayPal has indicated that it is now processing nearly $8 million in mobile transactions per day, and forecasts total mobile payment volume of $3 billion in 2011 (vs. just $24 million in 2008). We believe that the vast majority of these PayPal mobile payments are e-commerce purchases made via mobile browsers, rather than payments at a physical POS (though they also include a much smaller amount of P2P payments volume, some derived using PayPal's innovative Bump service).

eBay/PayPal has indicated that it intends to be technology agnostic when it comes to mobile payments. In terms of mobile payments at the physical POS, PayPal has had exposure to contactless mobile payments via its partnership with Bling Nation, and has implemented a program with VIVO (a large Brazilian Mobile Carrier) that allows account holders to pay for airtime and other goods and services using basic GSM data protocols that put a purchase menu directly on the phone. In addition, EBay/PayPal's recent acquisition of Fig Card (which permits brick-and-mortar merchants to accept non-NFC mobile payments via a small piece of proprietary plug-in hardware) demonstrates PayPal's broad bets in the mobile POS payments space.

PayPal would seem to enjoy some advantages in developing a mobile POS payments system: 1) a very large base of existing users (including possession of their payment credentials), 2) an existing merchant acceptance network (though many of these small e-businesses may not have a need for physical POS processing), and 3) a very successful barcode-lookup mobile marketing application, Red Laser, which has allowed PayPal to capture the mobile numbers of a meaningful percentage of its user base.

At the same time, we believe PayPal faces some mobile POS payment hurdles specifically when it comes to processing transactions from its ACH-linked (as opposed to debit/credit card-linked) accounts (approx. 25% of total accounts we believe). The ACH system was originally designed for inter-bank electronic funds transfer, and therefore does not provide a real time mechanism for PayPal (and its merchant customer) to verify if there are sufficient funds in the receiver's (i.e., the consumer's) bank account. In the e-commerce environment, many (though not all) purchases are for goods which are fulfilled/shipped later. This delay provides PayPal with a greater opportunity to conduct fraud screening on these transactions, we believe, as opposed to mobile POS purchases, where goods are handed over immediately.

We also believe that PayPal has approached the retail POS gingerly because the National Association of Clearing House Agents' (NACHA—the governing body overseeing the ACH network) rules for ACH transactions that are initiated from the physical point of sale might serve to increase PayPal's per-transaction costs, in a mobile POS context. First, NACHA does not permit payment aggregators like PayPal to bundle many different ACH-based transactions together before submission for settlement if the transactions were made at a physical point of sale (or ATM). NACHA rules do, however, permit bundling if the transaction can be categorized as Internet-based. We therefore believe that under current NACHA regulations, PayPal might be compelled to submit each Mobile POS payment in a separate settlement action, which may have the effect of eroding per-transaction margins for PayPal (assuming PayPal did not pass costs along to the merchant), if the company could not find a way to categorize its physical POS payments as web-based.

Google

Goal: Capture targeted mobile advertising spend

Elements of Google's mobile payments strategy can be discerned from its recently disclosed mobile payments pilot program, known as Google Wallet. The pilot will allow Citigroup account holders to link their PayPass-enabled MasterCard debit/credit cards to an electronic wallet/mobile-payment app developed for the Nexus-S wireless handset (developed jointly by Google and Samsung), powered by Sprint, and provisioned by First Data. The phone would rely on near field communication at the POS—a technology already built into both the Nexus-S handset itself, as well as pre-integrated into the phone's Google Android operating system. Google has announced that retailers participating in the pilot include American Eagle Outfitters, Subway, Macy's, Bloomingdale's, The Container Store, Duane Reade, Einstein Bros. Bagels, Foot Locker, Guess, Jamba Juice, Peet's Coffee & Tea, RadioShack, Toys"R"Us and Walgreens.

Google does not intend to take a cut of mobile payments transaction-based revenue but rather derive revenue from mobile targeted consumer ads/discount offers sold to participating to retailers

A critical detail of the pilot is that Google does not intend to take a cut of the transaction economics. Instead, Google evidently plans to derive revenue from targeted ad/discount offers pushed to users, which the company hopes to sell to retailers participating in the pilot (we are currently unaware of which retailers may participate). We believe that this aspect of Google's solution (i.e., that it does not intend to capture a portion of transaction fees) gives the company a significant advantage when it comes to forging the partnerships required to get a mobile POS payments solution to market. In other words, while competitors must split transaction processing fees with partners, Google's business model will rely instead on advertising revenue, likely providing a greater amount of transaction fee revenue for the rest of the value chain. Just as important, Google has indicated that it intends to keep its platform open to different payment networks, telco carriers, merchants, issuing banks, and handset manufacturers.

Apple

Goal: Undefined (but probably capturing targeted advertising spend)

Apple's reported 200M iTunes customer relationships (including payment information, as these accounts are typically funded by V/MA/AXP/DFS cards), would seem to provide an advantage if the company were to decide to build a mobile payments solution. We believe Apple has been experimenting with NFC capabilities for its iPhone handsets/operating system (though the company does not intend to include NFC capabilities into its next-generation iPhone, expected later in 2011).

We believe that Apple may be primarily interested (at least in the medium term) in developing: 1) a mobile targeted ad/marketing offer capability, and 2) utilizing NFC to facilitate (non-payment-related) communication between iPhones and other Apple hardware, such as iMac computers. We believe that Apple is primarily interested in developing a mobile POS payments system in order to track the efficacy of its targeted ads (rather than to capture transaction revenue).

Apple is primarily interested in developing a mobile POS payments system in order to track the efficacy of its targeted ads (rather than to capture transaction revenue)

We can guess at two potential features of a future iPhone-based NFC payments system by looking at recent Apple patent filings: 1) the NFC secure element and a core app may be built into the phone, and 2) there may be a biometric strip (presumably enabling fingerprint authentication).

We note that Apple currently offers a Starbucks mobile payments app, linked to customers' existing credit or debit cards that can be used to make purchases at participating Starbucks. The app employs a barcode displayed on the iPhone screen that can be scanned at the POS. We do not, however, view this closed-loop payments solution as a game-changer in the context of the overall payments market.

Isis

Goal: Capture transaction-based revenues

Isis is the mobile payments joint venture of AT&T, Verizon Wireless, and T-Mobile (in process of being acquired by AT&T), launched in August 2010. The JV indicated that it would launch its products in select markets within 18 months of the August 2010 announcement (i.e., Feb. 2012). In April 2011, Isis announced its first pilot implementation: setting up the entire Utah Transit Authority system to be Isis-enabled by early- to mid-2012. The JV then intends to roll out Isis acceptance at Salt Lake City area merchants, so that transit customers can make purchases in local stores. Testing in a second test market (Austin, Texas) is planned soon thereafter.

Since launch, only a handful of details about the service have been made public, including:

- The Isis solution will utilize NFC technology
- Barclays will be the first issuing bank to make Isis available to its account holders;
- Other banks and payment networks will be invited to participate. To date, Visa, MasterCard, American Express (AXP, $49.71, NC), and Discover (DFS, $25.16, NC) have signalled their intention to participate.

- The program will offer mobile marketing services such as advertising, coupons, loyalty programs, and ticketing
- The JV intends to absorb the cost of adding NFC capabilities to handsets

The pending industry adoption of Open NFC architecture has compelled Isis to alter its original "closed network" strategy, and instead embrace a more inclusive model

While the details of the Isis program are limited, we believe that the potential pending industry adoption of Open NFC architecture described above (see "Mobile POS payments architecture: OpenNFC could be a game changer") has compelled Isis to alter its original strategy. Initially, we think that Isis was counting on being the sole party responsible for provisioning subscribers' credentials to each handset's secure element. Now, however, Open NFC has opened up this capability to non-telco third parties. As long as the handset is NFC enabled, and the Open NFC architecture/protocol is employed, non-telcos such as Google, Visa, MasterCard, Amazon, PayPal, and Amex can effectively run payments applications on the phones alongside the Isis payment solution, thereby potentially taking ownership of the mobile user's credentials (and related transaction data).

We believe that Isis' recent comments regarding a more open system architecture, one where different issuers, payment networks, telcos and other parties can participate, have been motivated, at least in part, by the increased competition enabled by Open NFC. This dynamic culminated with the July 2011 announcement that V and MA are joining Isis' open platform.

Another key outstanding issue regarding Isis is its fee structure, as economics must be shared among the telco carriers, payment networks, and issuers. Our checks indicate that the Isis fee structure is yet to be fully worked out, and that the initial response to Isis from some large merchants was tepid due to the resemblance of the Isis model to the existing card networks (i.e., V/MA) interchange fee model.

We further believe that the Fed's final Durbin Amendment rules (issued 6/29) may have an adverse impact on Isis. The final debit interchange rate cap ($0.24) is likely to erode Isis' value proposition, as pricing lower than traditional debit interchange rates will no longer be an effective competitive differentiator to merchants, we believe.

We note further that Isis is far from alone in creating a neutral, open mobile payments platform. We believe that Google's Android-based solution, as well as AXP's and PayPal's gradually coalescing strategies also have similar, participant-agnostic, characteristics.

American Express

Goal: Capture transaction-based revenues

We believe that AXP is gradually assembling the components to launch a mobile POS payments service. The first building block was AXP's $300M acquisition of Revolution Money in 2010, whose platform forms the basis of AXP's new digital payments product, called Serve. Serve is a plastic card that is linked to an account holder's credit card/debit card/ or bank account. It can be used to make purchases, as well as ATM withdrawals and P2P payments with other Serve users, and is accepted across AXP's broad network of participating merchants. It is important to note that Serve is not required to be linked to an AXP account, meaning that users can link the card to any issuer's/network's card or account (e.g., a JP Morgan Visa debit card). Serve therefore functions like an issuer/network agnostic prepaid e-wallet (similar to a PayPal debit card).

AXP intends to use its Serve platform as the engine for mobile POS payments programs

We believe that AXP could intend to use Serve as the engine for its mobile POS payments programs. One part of AXP's strategy may be to roll out a program that leverages an innovative transaction authorization technology made available via AXP's recent $19M investment in Payfone, Inc. Unlike other mobile POS payments systems that rely on transaction messaging (e.g., authorization, etc.) that is sent back and forth from merchant to issuer (via the networks like V/MA), Payfone's solution instead relies on the cell phone network itself to validate a user's identify. Payfone does this by leveraging the same technology used when a cell phone user first "roams" out of their carrier's network grid, and onto a grid belonging to another carrier. The instant a call is made after entering another carrier's grid, the networks exchange information to ensure that the user can pay the requisite roaming fees. We believe that Payfone uses a similar process when a mobile POS payment is made, meaning that Payfone uses the host wireless telco carrier's authentication process to validate the transaction. Whether or not NFC becomes the dominant communication protocol for mobile POS payments, AXP has the basic transaction engine in place (i.e., Serve/Payfone) to authorize transactions (as well as the ability to leverage carrier data and unique assigned user IDs to provide effective fraud screening/controls).

We believe that AXP's Payfone investment gains importance in the context of the recently announced AXP/Verizon (VZ) partnership, where AXP's Serve e-wallet will be integrated into Verizon mobile handsets and tablets. While Serve is likely to be used initially by Verizon subscribers to make online purchases via a mobile internet browser, a tie in with a mobile POS payments system such as Isis (Verizon is a part of the Isis JV) might see Serve also become an e-wallet underlying mobile payments at the physical point of sale.

In addition, nothing is stopping AXP from simultaneously developing other mobile POS payments capabilities leveraging the underlying Serve engine, and utilizing different authorization methods. We believe that it is a safe bet AXP is not putting all of its mobile payments eggs in one, Payfone-enabled, basket.

Research in Motion (Blackberry)

Goal: capture transaction-based revenues

We view RIMM as possessing some unique advantages when it comes to mobile POS payments. First and foremost, RIMM assigns a unique identifier to each BlackBerry phone (called a PIN—not to be confused with a debit card's personal identification number). RIMM is thus able to allow any Blackberry user, on any carrier's service, to send highly encrypted messages to any other Blackberry user. This permanent system of identification, maintained by RIMM (as opposed to by the telco carriers), allows the company to locate any Blackberry device on its network at any time.

What it may also mean, in the context of mobile POS payments, is that RIMM has the option to provision its NFC-enabled phones (i.e., those with both an NFC chip and secure element embedded in the phone) remotely via the previously discussed OpenNFC protocol, thereby providing a mobile POS payment system independent of the telco carriers that provide phone service.

RIM may have the ability to roll out any new mobile payments programs to something analogous to a captive customer base

Another RIMM advantage has to do with its corporate/institutional-heavy business model. As RIMM is a long-time provider of mobile telecom hardware to businesses and other large organizations, the company may have the ability to roll out any new mobile payments capabilities to something analogous to a captive customer base. RIMM has indicated that it intends to include NFC capabilities into upcoming 2011 handset models (such as Torch2 and Bold, we believe), which means that many employees of RIMM corporate customers will likely receive NFC enabled phones in the near term.

RIMM also has a longstanding partnership with MA, and has run contactless mobile PayPass sticker pilots in conjunction with Bank of Montreal in Canada. It is not difficult to imagine RIMM rolling out a mobile POS payments program to existing MasterCard corporate/commercial credit card clients. The phone's secure element might be linked to employee corporate cards.

Complicating matters for RIMM is that they have historically worked very closely with telco carriers/MNOs, and in fact rely on them heavily for distribution (RIM's market share has slipped in recent years due to penetration by Apple's iPhone and smart phones using Google's Android). Taking all this into account, it would appear that obstacles that RIMM would need to overcome to develop a mobile POS payments program may have more to do with political considerations regarding RIMM's telco carrier/MNO partners, than technological obstacles.

Mobile POS payments: Developments outside the US

We believe that the mobile POS payments have been most transformative in a handful of emerging economies that largely lacked widespread electronic consumer payments infrastructure. The most notable example is Kenya's Safaricom/Vodafone joint venture called M-PESA. Originally intended as a system to allow microfinance borrowers to repay loans electronically, leveraging the large network of Safaricom agent locations (~12K), the service was repurposed by users to: 1) make domestic money transfers from urban to rural areas, and 2) to make retail consumer payments.

Official ID is required for registration, after which point users exchange actual money (deposited at Safaricom agent locations) for credits called "e-float." There is no charge for loading funds, but withdrawals are subject to a sliding fee scale (we believe it costs ~$1.00 to withdraw $100, for example). E-float is then transferred from one customer's account to another using an SMS text-message based system. The originator or sender of the transfer is charged a flat fee (~$0.40, we believe).

The service has proven to be extremely popular. As of the beginning of 2010, 57% of the adult male population of Kenya (13.3M people) was an M-PESA user. Accordingly M-PESA has demonstrated the potential of mobile payments to capture significant market share in emerging markets whose economies have historically been cash based. A Version of M-PESA has also been rolled out in Tanzania and Afghanistan.

In more economically mature economies, mobile payments have met with varying degrees of success. NTT DoCoMo's Felica program in Japan has changed from a transit-specific mobile payments solution into a broader mobile payments solution, accepted nationally by merchants and vending machines (often in proximity to transit hubs). DoCoMo licences its mobile payments platform to other providers (e.g., KDDI and Vodafone/Softbank). The Felica service can be considered a cash substitute, which we believe is the reason why, despite over 70% of Japanese phones carrying a mobile payments capability, only a low-single-digit percentage of total Japanese consumer spending occurs via mobile payments.

The most notable failure of a mobile payments program in an international market is the Spanish MobiPay venture owned jointly by large mobile carriers, banks and payment card providers. Mobipay was designed to be an e-wallet where a consumer could link different funding sources/accounts. Purchases entailed MobiPay users provide participating retailers with either a registered phone number, or a barcode generated on the phone's screen (that the retailer would scan). The program was free to all parties (i.e., consumers and merchants), which meant that few marketing dollars to promote the program were available, we believe. As a result, we estimate that less than one percent of the Spanish population signed up for the service since the program's inception in 2001.

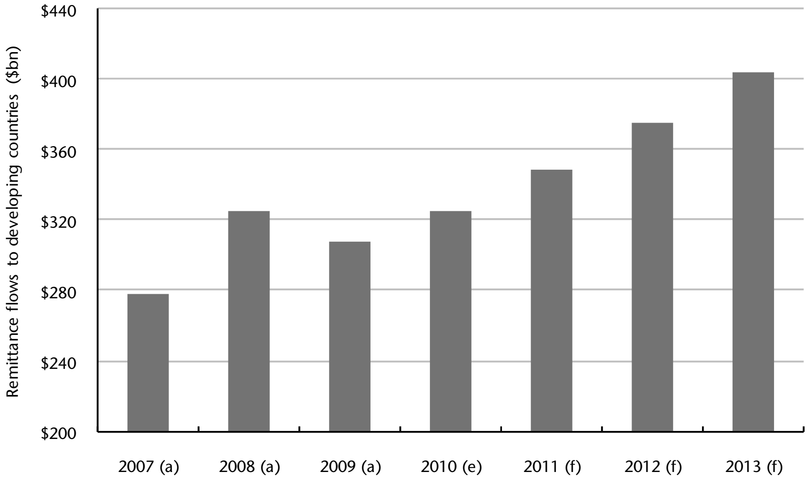
Mobile peer-to-peer (P2P) payments

This category itself consists of a handful of smaller segments that overlap to some degree, as the difference between P2P *money transfers* vs. P2P *payments* is not clear cut. For example, sending money to loved ones abroad, settling a shared dinner tab, or purchasing an item at a garage sale can all be achieved with the same mobile P2P payments system.

V, MA, and DFS (in conjunction with PayPal) have enabled their existing card-based remittance services to operate in the mobile environment

We believe that the mobile P2P payments market sub-segment with the largest potential volume is international remittance (see exhibit below), where a migrant worker would send money home to relatives abroad. Given the ubiquity of mobile phones in both developed and developing economies, this segment has attracted attention from both new and established industry players. V, MA, and DFS (in conjunction with PayPal) have all enabled their existing card-based remittance services (which can be used to send funds internationally) to operate in the mobile environment, whether via mobile browser, smartphone app, or SMS text messaging. PayPal's popular service can also be used to transfer funds internationally via a mobile app (or through a mobile browser/SMS messaging).

Exhibit 132: Developing Countries Remittance (2007-2013E, $ in billions)



Source: World Bank.

While the market opportunity for Mobile remittance appears large, the cash-preference of both senders and recipients of international remittance payments itself makes mobile a less than ideal format for transfers

We believe, however, that successful international mobile remittance programs continue to require widely-dispersed physical pay-in and pay-out networks, as cash is still the dominant tender type for both migrant workers who send funds and their relatives abroad who receive funds. In developing economies, banks do not necessarily make optimal payout networks due to their relatively affluent customer base, which makes the distribution assets of non-bank players such as WU, all the more formidable as a barrier of entry.

We believe that while the market opportunity for mobile remittance appears large, the cash-preference of both senders and recipients of international remittance itself forms a barrier difficult for mobile remittance providers to overcome. As a result, we do not subscribe to the thesis that suggests the traditional cash-based remittance model will be disintermediated by mobile channels in a major way any time in the foreseeable future. We also note that entrenched incumbent vendors in the global remittance market (such as WU) have been making investments in the mobile channel to accommodate the segment of their customer base who does prefer to transact electronically rather than with cash.

Other mobile P2P payments may include paying an individual for a non-business purchase (ie, paying for a classified ad purchase), parents transferring money to college students, and other ad hoc transfers. We believe that PayPal—the leader in the general, non-mobile P2P payments space—is enjoying the advantage of porting its existing capabilities and customers to a mobile format, making it perhaps the most formidable mobile P2P payments competitor. PayPal's service has been integrated by partners such as DFS and FIS, thereby expanding the company's distribution.

It should be noted that developing economies with limited existing electronic payments infrastructure provide the most conducive environment for widespread adoption of mobile P2P payments. We believe that in developed economies, however, the mobile P2P segment is likely to remain a niche in the larger mobile payments category.

Mobile e-commerce

Mobile e-commerce refers to online purchases made using a mobile device rather than a computer. We believe that as smart phones and tablets become more ubiquitous, and online retailers retool/optimize their websites for mobile use, an increasing number of online purchases will be made using mobile Internet browsers rather than stand-alone computers. We note that eBay reported 134% y/y growth in US sales initiated over mobile devices during the 2010 holiday shopping season. Likewise, CoreMetrics reported that on Black Friday (2010), 5.6% of consumers logged onto merchant websites with a mobile device, which is a 16.7% y/y improvement vs. 2009.

Digital goods comprise a large mobile e-commerce segment. The dominant player in this space is Apple (i.e., App store and iTunes purchases via the iPhone/iPad). iTunes purchase volume totalled $1.4 billion during Apple's 3Q2011, representing a 36% y/y increase (though the company does not break out how much of this volume is computer-based, as opposed to mobile device-based [i.e., iPhone/iPad]). Despite the rapid growth of purchase volume related to digital goods (including mobile video games), we believe this is likely to remain a relatively niche category.

A more compelling opportunity for mobile e-commerce may be the use of shopping enhancement tools (e.g., bar code-scan/price comparison apps, listings of additional inventory options, click-throughs from proximity ads/offers, etc.) to persuade customers about to make purchases in a bricks-and-mortar retailer to instead buy the item via a mobile browser/app. On the one hand, this mobile enhanced shopping experience may present a disruptive threat to physical retailers. For example, Amazon.com might use a bar-scan price comparison tool connected to Amazon's mobile app to inspire a consumer about to purchase an item in a Best Buy (BBY, $25.59, Hold) location to instead buy the same item on Amazon.com for a cheaper price. On the other hand this dynamic may provide a boon to retailers, who can use an enhanced shopping experience to persuade shoppers to make purchases with targeted discounts/offers or expanded inventory.

Mobile phone payment acceptance

In many ways, the value proposition created when a mobile phone is transformed into a payment acceptance device is similar to that of P2P payments: namely, the relatively large, informal, micro-business economy (i.e., hobbyists, swap meets, flea markets, bake sales, etc.) currently employ cash and check only. The hope is that mobile phone enabled acceptance can convert a portion of this cash volume to electronic payments.

Since the high-profile 2010 launch of Twitter-founder Jack Dorsey's iPhone acceptance solution, Square, a flood of similar offerings have entered the market (we define mobile device acceptance as transforming a mobile phone/tablet into an acceptor of electronic payments, as opposed to a traditional credit card terminal with wireless connectivity). Square operates by distributing a small, plastic peripheral that plugs into the iPhone's headphone jack, and allows users to swipe magnetic swipe payment cards for processing. V's recent small investment (and the PCI compliance that V required, we believe, as a prerequisite for investment) has served to validate Square's model.

A similar solution is offered by Verifone, who, in partnership with PayPal, provides merchants with its PayWare solution consisting of a smart phone app and physical plastic sleeve that together serve to integrate the iPhone with PayPal's existing Internet payment acceptance offerings. VeriFone touts the end-to-end encryption permitted by its plastic sleeve/card reader, and has been a very vocal critic of competitor Square, claiming that the start-up unencrypted magnetic-swipe reading peripheral constitutes a security risk. Intuit also markets a half-moon shaped smart phone peripheral under the Go-payments brand that enables users to swipe and process payment cards (Intuit's solution provides end-to-end-encryption).

Likewise, PayPal has recently acquired payments start-up Fig Card, which offers a system that lets merchants accept mobile payments via a USB device that plugs into an electronic cash register. Customers would download a Fig app onto their phones, but no additional hardware is required (e.g., an NFC-enabled handset).

We view mobile acceptance as a segment that may enjoy rapid growth over the next 3-5 years, but one that is likely to remain more of a niche segment

There are many other mobile phone card processing options available, though most do not include a peripheral for card swipes, but rather require the user to type customer card data into an application. We view mobile acceptance as a segment that may enjoy rapid growth over the next 3-5 years, but one that is likely to remain relatively small in the context of the overall electronic payments market.

Expect Visa and MasterCard to benefit from mobile payments

We believe that Visa and MasterCard's main strategic priorities when it comes to mobile payments are to: 1) remain an integral component of the payments value chain (i.e., prevent disintermediation), and 2) participate in mobile payments in such a way as to roughly preserve existing card-based per-transaction revenue yields, while leveraging the mobile channel as an avenue to convert more paper-based payments to an electronic form. Despite mobile payments' nascent developmental stage, we believe that mobile payments (in the U.S.) have recently began evolving in ways that will help V and MA make headway toward achieving these goals. We further note that V and MA seem also to be laying the groundwork for participation in mobile payments in global markets (a prime example being MA's recent Telefonica JV in Latin America), where overall penetration of electronic payments is much lower than in developed countries, and therefore mobile form factors could help accelerate the disintermediation of cash, benefitting V and MA.

As mentioned previously, we believe that Open NFC could fundamentally alter the competitive dynamics in the industry, because many industry participants, V/MA notwithstanding, no longer are forced to rely on the telcos/MNOs for access to end user credentials. With Open NFC, V/MA can now partner with handset manufacturers and others (e.g., Google, Amazon, etc.), to penetrate telco/MNO customer bases that would otherwise have been walled off.

We believe that this change is reflected in the recently announced Google/MasterCard/Citi/First Data pilot that leverages Samsung's Nexus S NFC-enabled phones. Whereas previously, MA had been experimenting with relatively cumbersome "work-arounds" such as RFID stickers, it would appear that meaningful resources are being directed at the Open NFC based approach. The mobile telco's remaining leverage, when it comes to mobile payments, has to do with potentially refusing to continue subsidizing handsets that were OpenNFC enabled. We believe that Sprint's participation in the Google pilot demonstrates that, in the final analysis, telcos will need to relax their grip on handset architecture and provisioning, or risk being bypassed by competitors.

The market entry of companies such as Apple, Google, and Amazon into the US mobile payments market benefits V and MA because we believe that these non-traditional players are not primarily interested in transaction fee revenue, but rather seek to expand existing lucrative Internet-based business models into the physical retail environment. It is notable that there does not appear currently to be a single high-profile mobile payments pilot that disintermediates V and MA (even Isis has extended an olive branch to the brand networks).

If these new deep-pocketed industry participants rely on advertising/couponing/marketing revenue, and opt to leave the existing payments value chain intact, we believe that mobile payments adoption by both US merchants and consumers could potentially happen sooner than expected.

Appendix: Mobile Industry Models

Exhibit 133: Mobile Unit Shipments by Region and Technology, 2008-2020E

(Units, K)	Generation	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Global	**Total**	**1,222,252**	**1,211,237**	**1,596,805**	**1,748,121**	**1,858,118**	**1,988,745**	**2,137,956**	**2,298,708**	**2,452,115**	**2,602,067**	**2,769,665**	**2,928,849**	**3,103,531**
	2G	800,766	677,756	844,557	826,629	726,859	609,879	499,959	371,119	258,407	175,431	104,092	56,665	28,943
	3G	421,485	533,481	752,230	917,251	1,117,677	1,338,318	1,549,107	1,769,309	1,937,756	2,062,609	2,187,452	2,275,587	2,361,930
	4G	0	0	18	4,241	13,582	40,548	88,890	158,280	255,952	364,027	478,121	596,597	712,658
Asia/Pacific ex. Japan	**Total**	**453,100**	**483,471**	**757,513**	**913,066**	**998,458**	**1,093,830**	**1,202,174**	**1,319,964**	**1,428,497**	**1,529,727**	**1,641,857**	**1,737,825**	**1,856,903**
	2G	329,681	329,061	496,686	521,520	469,368	398,963	319,170	223,419	145,222	94,395	51,917	25,959	12,979
	3G	123,420	154,410	260,827	391,241	528,175	686,627	858,284	1,047,106	1,204,172	1,324,590	1,457,049	1,559,042	1,668,175
	4G	0	0	0	305	916	8,240	24,719	49,439	79,102	110,743	132,891	152,825	175,748
Eastern Europe	**Total**	**96,068**	**79,510**	**104,448**	**108,843**	**113,980**	**120,486**	**128,728**	**137,869**	**148,208**	**159,003**	**170,836**	**182,616**	**192,778**
	2G	70,413	49,174	54,984	49,486	39,589	29,692	23,753	19,003	14,252	9,976	5,986	2,993	1,496
	3G	25,655	30,335	49,464	59,357	74,196	89,035	97,939	104,795	110,034	115,536	121,313	127,378	131,200
	4G	0	0	0	0	195	1,759	7,036	14,072	23,922	33,490	43,537	52,245	60,082
Latin America	**Total**	**142,323**	**117,122**	**155,379**	**158,828**	**161,152**	**168,661**	**177,376**	**188,882**	**201,949**	**215,818**	**230,245**	**245,407**	**261,067**
	2G	135,227	102,914	131,557	130,242	123,730	111,357	94,653	75,723	56,792	39,754	25,840	15,504	7,752
	3G	7,096	14,207	23,822	28,586	37,162	55,743	78,040	101,452	121,742	133,917	143,291	150,455	157,978
	4G	0	0	0	0	260	1,561	4,683	11,708	23,415	42,147	61,113	79,447	95,337
Middle East & Africa	**Total**	**133,471**	**125,006**	**155,876**	**159,383**	**164,718**	**173,801**	**182,819**	**191,827**	**198,150**	**203,355**	**204,442**	**205,507**	**209,677**
	2G	107,993	93,472	99,370	94,401	80,241	68,205	61,384	52,177	41,741	31,306	20,349	12,209	6,715
	3G	25,479	31,534	56,506	64,982	84,477	105,596	121,435	139,650	156,409	172,049	184,093	193,297	202,962
	4G	0	0	0	0	36	326	1,953	4,884	10,988	19,230	33,652	50,478	63,098
Northern America	**Total**	**182,246**	**182,569**	**191,576**	**188,492**	**195,983**	**202,542**	**208,285**	**213,564**	**217,374**	**223,350**	**230,079**	**236,648**	**242,215**
	2G	70,745	53,346	26,609	13,304	3,326	1,663	998	798	399	0	0	0	0
	3G	111,501	129,224	164,949	171,547	183,555	187,226	186,807	183,071	173,918	165,222	148,700	130,856	104,685
	4G	0	0	18	3,641	9,102	13,653	20,479	29,695	43,058	58,128	81,379	105,793	137,530
Western Europe	**Total**	**174,455**	**189,775**	**197,907**	**185,108**	**188,406**	**193,108**	**199,864**	**204,059**	**207,975**	**211,499**	**217,589**	**228,662**	**234,644**
	2G	86,557	49,788	35,352	17,676	10,605	0	0	0	0	0	0	0	0
	3G	87,898	139,987	162,556	167,432	177,478	186,352	186,352	177,035	159,331	143,398	129,058	113,571	96,536
	4G	0	0	0	0	322	6,756	13,512	27,024	48,643	68,101	88,531	115,090	138,108
Japan	**Total**	**40,588**	**33,785**	**34,106**	**34,401**	**35,385**	**35,992**	**36,756**	**37,659**	**38,974**	**40,086**	**40,966**	**41,706**	**43,150**
	2G	152	0	0	0	0	0	0	0	0	0	0	0	0
	3G	40,436	33,785	34,106	34,106	32,634	27,739	20,249	16,199	12,150	7,897	3,949	987	395
	4G	0	0	0	295	2,751	8,254	16,507	21,459	26,824	32,189	37,017	40,719	42,755
Note:														
Total Europe	**Total**	**270,523**	**269,285**	**302,356**	**293,951**	**302,386**	**313,594**	**328,592**	**341,927**	**356,183**	**370,502**	**388,425**	**411,278**	**427,422**
	2G	156,969	98,962	90,336	67,162	50,194	29,692	23,753	19,003	14,252	9,976	5,986	2,993	1,496
	3G	113,553	170,322	212,020	226,789	251,674	275,388	284,291	281,829	269,365	258,934	250,371	240,950	227,735
	4G	0	0	0	0	517	8,515	20,548	41,096	72,565	101,591	132,068	167,335	198,190
Total Asia	**Total**	**493,688**	**517,256**	**791,619**	**947,467**	**1,033,843**	**1,129,822**	**1,238,930**	**1,357,623**	**1,467,470**	**1,569,813**	**1,682,822**	**1,779,531**	**1,900,052**
	2G	329,833	329,061	496,686	521,520	469,368	398,963	319,170	223,419	145,222	94,395	51,917	25,959	12,979
	3G	163,856	188,195	294,933	425,347	560,809	714,366	878,533	1,063,306	1,216,322	1,332,487	1,460,997	1,560,029	1,668,570
	4G	0	0	0	600	3,667	16,493	41,226	70,898	105,926	142,931	169,908	193,544	218,503

Source: Jefferies & Co. estimates. Note: actual through 2010

Exhibit 134: Annual Growth of Mobile Shipments by Region and Technology, 2009-2020E

Y/Y Sell-Through	**Generation**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Global	**Total**	**-1%**	**32%**	**9%**	**6%**	**7%**	**8%**	**8%**	**7%**	**6%**	**6%**	**6%**	**6%**
	2G	-15%	25%	-2%	-12%	-16%	-18%	-26%	-30%	-32%	-41%	-46%	-49%
	3G	27%	41%	22%	22%	20%	16%	14%	10%	6%	6%	4%	4%
	4G				220%	199%	119%	78%	62%	42%	31%	25%	19%
Asia/Pacific ex. Japan	**Total**	**7%**	**57%**	**21%**	**9%**	**10%**	**10%**	**10%**	**8%**	**7%**	**7%**	**6%**	**7%**
	2G	0%	51%	5%	-10%	-15%	-20%	-30%	-35%	-35%	-45%	-50%	-50%
	3G	25%	69%	50%	35%	30%	25%	22%	15%	10%	10%	7%	7%
	4G				200%	800%	200%	100%	60%	40%	20%	15%	15%
Eastern Europe	**Total**	**-17%**	**31%**	**4%**	**5%**	**6%**	**7%**	**7%**	**7%**	**7%**	**7%**	**7%**	**6%**
	2G	-30%	12%	-10%	-20%	-25%	-20%	-20%	-25%	-30%	-40%	-50%	-50%
	3G	18%	63%	20%	25%	20%	10%	7%	5%	5%	5%	5%	3%
	4G					800%	300%	100%	70%	40%	30%	20%	15%
Latin America	**Total**	**-18%**	**33%**	**2%**	**1%**	**5%**	**5%**	**6%**	**7%**	**7%**	**7%**	**7%**	**6%**
	2G	-24%	28%	-1%	-5%	-10%	-15%	-20%	-25%	-30%	-35%	-40%	-50%
	3G	100%	68%	20%	30%	50%	40%	30%	20%	10%	7%	5%	5%
	4G					500%	200%	150%	100%	80%	45%	30%	20%
Middle East & Africa	**Total**	**-6%**	**25%**	**2%**	**3%**	**6%**	**5%**	**5%**	**3%**	**3%**	**1%**	**1%**	**2%**
	2G	-13%	6%	-5%	-15%	-15%	-10%	-15%	-20%	-25%	-35%	-40%	-45%
	3G	24%	79%	15%	30%	25%	15%	15%	12%	10%	7%	5%	5%
	4G					800%	500%	150%	125%	75%	75%	50%	25%
Northern America	**Total**	**0%**	**5%**	**-2%**	**4%**	**3%**	**3%**	**3%**	**2%**	**3%**	**3%**	**3%**	**2%**
	2G	-25%	-50%	-50%	-75%	-50%	-40%	-20%	-50%	-100%			
	3G	16%	28%	4%	7%	2%	0%	-2%	-5%	-5%	-10%	-12%	-20%
	4G			20000%	150%	50%	50%	45%	45%	35%	40%	30%	30%
Western Europe	**Total**	**9%**	**4%**	**-6%**	**2%**	**2%**	**3%**	**2%**	**2%**	**2%**	**3%**	**5%**	**3%**
	2G	-42%	-29%	-50%	-40%	-100%							
	3G	59%	16%	3%	6%	5%	0%	-5%	-10%	-10%	-10%	-12%	-15%
	4G					2000%	100%	100%	80%	40%	30%	30%	20%
Japan	**Total**	**-17%**	**1%**	**1%**	**3%**	**2%**	**2%**	**2%**	**3%**	**3%**	**2%**	**2%**	**3%**
	2G	-100%											
	3G	-16%	1%	0%	-4%	-15%	-27%	-20%	-25%	-35%	-50%	-75%	-60%
	4G				832%	200%	100%	30%	25%	20%	15%	10%	5%
Note:													
Total Europe	**Total**	**0%**	**12%**	**-3%**	**3%**	**4%**	**5%**	**4%**	**4%**	**4%**	**5%**	**6%**	**4%**
	2G	-37%	-9%	-26%	-25%	-41%	-20%	-20%	-25%	-30%	-40%	-50%	-50%
	3G	50%	24%	7%	11%	9%	3%	-1%	-4%	-4%	-3%	-4%	-5%
	4G					1547%	141%	100%	77%	40%	30%	27%	18%
Total Asia	**Total**	**5%**	**53%**	**20%**	**9%**	**9%**	**10%**	**10%**	**8%**	**7%**	**7%**	**6%**	**7%**
	2G	0%	51%	5%	-10%	-15%	-20%	-30%	-35%	-35%	-45%	-50%	-50%
	3G	15%	57%	44%	32%	27%	23%	21%	14%	10%	10%	7%	7%
	4G				511%	350%	150%	72%	49%	35%	19%	14%	13%

Source: Jefferies & Co. Inc. estimates. Note: actual through 2010

Exhibit 135: Percentage of Mobile Unit Shipments by Region and Technology, 2008-2020E

% of Global	Generation	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Asia/Pacific ex. Japan	**Total**	**37%**	**40%**	**47%**	**52%**	**54%**	**55%**	**56%**	**57%**	**58%**	**59%**	**59%**	**59%**	**60%**
	2G	41%	49%	59%	63%	65%	65%	64%	60%	56%	54%	50%	46%	45%
	3G	29%	29%	35%	43%	47%	51%	55%	59%	62%	64%	67%	69%	71%
	4G			0%	7%	7%	20%	28%	31%	31%	30%	28%	26%	25%
Eastern Europe	**Total**	**8%**	**7%**	**7%**	**6%**	**6%**	**6%**	**6%**	**6%**	**6%**	**6%**	**6%**	**6%**	**6%**
	2G	9%	7%	7%	6%	5%	5%	5%	5%	6%	6%	6%	5%	5%
	3G	6%	6%	7%	6%	7%	7%	6%	6%	6%	6%	6%	6%	6%
	4G			0%	0%	1%	4%	8%	9%	9%	9%	9%	9%	8%
Latin America	**Total**	**12%**	**10%**	**10%**	**9%**	**9%**	**8%**	**8%**	**8%**	**8%**	**8%**	**8%**	**8%**	**8%**
	2G	17%	15%	16%	16%	17%	18%	19%	20%	22%	23%	25%	27%	27%
	3G	2%	3%	3%	3%	3%	4%	5%	6%	6%	6%	7%	7%	7%
	4G			0%	0%	2%	4%	5%	7%	9%	12%	13%	13%	13%
Middle East & Africa	**Total**	**11%**	**10%**	**10%**	**9%**	**9%**	**9%**	**9%**	**8%**	**8%**	**8%**	**7%**	**7%**	**7%**
	2G	13%	14%	12%	11%	11%	11%	12%	14%	16%	18%	20%	22%	23%
	3G	6%	6%	8%	7%	8%	8%	8%	8%	8%	8%	8%	8%	9%
	4G			0%	0%	0%	1%	2%	3%	4%	5%	7%	8%	9%
Northern America	**Total**	**15%**	**15%**	**12%**	**11%**	**11%**	**10%**	**10%**	**9%**	**9%**	**9%**	**8%**	**8%**	**8%**
	2G	9%	8%	3%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	3G	26%	24%	22%	19%	16%	14%	12%	10%	9%	8%	7%	6%	4%
	4G			100%	86%	67%	34%	23%	19%	17%	16%	17%	18%	19%
Western Europe	**Total**	**14%**	**16%**	**12%**	**11%**	**10%**	**10%**	**9%**	**9%**	**8%**	**8%**	**8%**	**8%**	**8%**
	2G	11%	7%	4%	2%	1%	0%	0%	0%	0%	0%	0%	0%	0%
	3G	21%	26%	22%	18%	16%	14%	12%	10%	8%	7%	6%	5%	4%
	4G			0%	0%	2%	17%	15%	17%	19%	19%	19%	19%	19%
Japan	**Total**	**3%**	**3%**	**2%**	**2%**	**2%**	**2%**	**2%**	**2%**	**2%**	**2%**	**1%**	**1%**	**1%**
	2G	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	3G	10%	6%	5%	4%	3%	2%	1%	1%	1%	0%	0%	0%	0%
	4G			0%	7%	20%	20%	19%	14%	10%	9%	8%	7%	6%
Note:														
Total Europe	**Total**	**22%**	**22%**	**19%**	**17%**	**16%**	**16%**	**15%**	**15%**	**15%**	**14%**	**14%**	**14%**	**14%**
	2G	20%	15%	11%	8%	7%	5%	5%	5%	6%	6%	6%	5%	5%
	3G	27%	32%	28%	25%	23%	21%	18%	16%	14%	13%	11%	11%	10%
	4G			0%	0%	4%	21%	23%	26%	28%	28%	28%	28%	28%
Total Asia	**Total**	**40%**	**43%**	**50%**	**54%**	**56%**	**57%**	**58%**	**59%**	**60%**	**60%**	**61%**	**61%**	**61%**
	2G	41%	49%	59%	63%	65%	65%	64%	60%	56%	54%	50%	46%	45%
	3G	39%	35%	39%	46%	50%	53%	57%	60%	63%	65%	67%	69%	71%
	4G			0%	14%	27%	41%	46%	45%	41%	39%	36%	32%	31%

Source: Jefferies & Co. estimates. Note: actual through 2010

Exhibit 136: Technology Mix of Mobile Unit Shipments by Region and Technology, 2008-2020E

% of 2G-3G-4G	Generation	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Global	2G	66%	56%	53%	47%	39%	31%	23%	16%	11%	7%	4%	2%	1%
	3G	34%	44%	47%	52%	60%	67%	72%	77%	79%	79%	79%	78%	76%
	4G	0%	0%	0%	0%	1%	2%	4%	7%	10%	14%	17%	20%	23%
Asia/Pacific ex. Japan	2G	73%	68%	66%	57%	47%	36%	27%	17%	10%	6%	3%	1%	1%
	3G	27%	32%	34%	43%	53%	63%	71%	79%	84%	87%	89%	90%	90%
	4G	0%	0%	0%	0%	0%	1%	2%	4%	6%	7%	8%	9%	9%
Eastern Europe	2G	73%	62%	53%	45%	35%	25%	18%	14%	10%	6%	4%	2%	1%
	3G	27%	38%	47%	55%	65%	74%	76%	76%	74%	73%	71%	70%	68%
	4G	0%	0%	0%	0%	0%	1%	5%	10%	16%	21%	25%	29%	31%
Latin America	2G	95%	88%	85%	82%	77%	66%	53%	40%	28%	18%	11%	6%	3%
	3G	5%	12%	15%	18%	23%	33%	44%	54%	60%	62%	62%	61%	61%
	4G	0%	0%	0%	0%	0%	1%	3%	6%	12%	20%	27%	32%	37%
Middle East & Africa	2G	81%	75%	64%	59%	49%	39%	34%	27%	21%	15%	10%	6%	3%
	3G	19%	25%	36%	41%	51%	61%	66%	73%	79%	85%	90%	94%	97%
	4G	0%	0%	0%	0%	0%	0%	1%	3%	6%	9%	16%	25%	30%
Northern America	2G	39%	29%	14%	7%	2%	1%	0%	0%	0%	0%	0%	0%	0%
	3G	61%	71%	86%	91%	94%	92%	90%	86%	80%	74%	65%	55%	43%
	4G	0%	0%	0%	2%	5%	7%	10%	14%	20%	26%	35%	45%	57%
Western Europe	2G	50%	26%	18%	10%	6%	0%	0%	0%	0%	0%	0%	0%	0%
	3G	50%	74%	82%	90%	94%	97%	93%	87%	77%	68%	59%	50%	41%
	4G	0%	0%	0%	0%	0%	3%	7%	13%	23%	32%	41%	50%	59%
Japan	2G	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	3G	100%	100%	100%	99%	92%	77%	55%	43%	31%	20%	10%	2%	1%
	4G	0%	0%	0%	1%	8%	23%	45%	57%	69%	80%	90%	98%	99%
Note:														
Total Europe	2G	58%	37%	30%	23%	17%	9%	7%	6%	4%	3%	2%	1%	0%
	3G	42%	63%	70%	77%	83%	88%	87%	82%	76%	70%	64%	59%	53%
	4G	0%	0%	0%	0%	0%	3%	6%	12%	20%	27%	34%	41%	46%
Total Asia	2G	67%	64%	63%	55%	45%	35%	26%	16%	10%	6%	3%	1%	1%
	3G	33%	36%	37%	45%	54%	63%	71%	78%	83%	85%	87%	88%	88%
	4G	0%	0%	0%	0%	0%	1%	3%	5%	7%	9%	10%	11%	11%

Source: Jefferies & Co. estimates. Note: actual through 2010

Exhibit 137: Feature Phone vs. Smartphone Shipments by Region, 2008-2020E

(Units, K)	Device Type	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Global	**Total**	**1,222,251**	**1,211,238**	**1,596,805**	**1,748,121**	**1,858,082**	**1,988,420**	**2,136,002**	**2,293,824**	**2,441,127**	**2,582,838**	**2,736,013**	**2,878,371**	**3,040,434**
	Feature phone	1,082,960	1,038,862	1,297,959	1,298,517	1,213,950	1,162,227	1,111,804	944,259	886,129	818,856	744,482	656,327	585,543
	Smartphone	139,292	172,375	298,846	449,604	644,131	826,193	1,024,199	1,349,565	1,554,997	1,763,981	1,991,530	2,222,045	2,454,891
Asia/Pacific ex. Japan	Total	453,100	483,471	757,513	913,066	998,458	1,093,830	1,202,174	1,319,964	1,428,497	1,529,727	1,641,857	1,737,825	1,856,903
	Feature phone	424,981	445,892	684,064	778,634	748,844	743,804	733,326	607,184	585,684	550,702	508,976	451,835	408,519
	Smartphone	28,119	37,579	73,449	134,431	249,615	350,026	468,848	712,781	842,813	979,025	1,132,881	1,285,991	1,448,384
Eastern Europe	Total	96,068	79,510	104,448	108,843	113,980	120,486	128,728	137,869	148,208	159,003	170,836	182,616	192,778
	Feature phone	88,796	72,540	91,341	89,144	81,957	73,595	67,444	60,600	56,319	52,471	47,834	42,002	38,556
	Smartphone	7,272	6,970	13,107	19,699	32,023	46,891	61,284	77,269	91,889	106,532	123,002	140,615	154,222
Latin America	Total	142,323	117,122	155,379	158,828	161,152	168,661	177,376	188,882	201,949	215,818	230,245	245,407	261,067
	Feature phone	138,589	109,870	137,801	127,218	117,764	111,845	102,520	96,104	88,858	82,011	75,981	71,168	67,877
	Smartphone	3,734	7,252	17,578	31,610	43,388	56,815	74,856	92,778	113,092	133,807	154,264	174,239	193,190
Middle East & Africa	Total	133,471	125,006	155,876	159,383	164,718	173,801	182,819	191,827	198,150	203,355	204,442	205,507	209,677
	Feature phone	121,108	113,001	137,260	132,588	125,994	118,944	110,051	100,712	91,149	83,376	75,643	67,817	60,806
	Smartphone	12,363	12,004	18,615	26,796	38,723	54,857	72,768	91,115	107,001	119,980	128,798	137,690	148,871
Northern America	Total	182,246	182,569	191,576	188,492	195,983	202,542	208,285	213,564	217,374	223,350	230,079	236,648	242,215
	Feature phone	146,393	136,968	119,590	92,842	72,785	60,763	52,071	42,713	34,780	26,802	18,406	11,832	4,844
	Smartphone	35,853	45,602	71,986	95,650	123,198	141,780	156,213	170,852	182,595	196,548	211,672	224,816	237,371
Western Europe	Total	174,455	189,775	197,907	185,108	188,406	193,108	199,864	204,059	207,975	211,499	217,589	228,662	234,644
	Feature phone	142,252	144,234	111,723	69,292	62,174	52,139	45,969	36,731	29,116	23,265	17,407	11,433	4,693
	Smartphone	32,202	45,541	86,184	115,817	126,232	140,969	153,896	167,328	178,858	188,234	200,182	217,229	229,951
Japan	Total	40,588	33,785	34,106	34,401	35,385	35,992	36,756	37,659	38,974	40,086	40,966	41,706	43,150
	Feature phone	20,840	16,357	16,179	8,800	4,433	1,137	422	216	224	230	235	239	248
	Smartphone	19,748	17,428	17,927	25,602	30,952	34,856	36,334	37,442	38,750	39,856	40,731	41,467	42,902
Note:														
Total Europe	Total	270,523	269,285	302,356	293,951	302,386	313,594	328,592	341,927	356,183	370,502	388,425	411,278	427,422
	Feature phone	231,048	216,774	203,064	158,435	144,131	125,734	113,413	97,330	85,435	75,736	65,241	53,435	43,248
	Smartphone	39,475	52,510	99,292	135,516	158,255	187,860	215,179	244,597	270,747	294,766	323,184	357,843	384,173
Total Asia	Total	493,688	517,256	791,619	947,467	1,033,843	1,129,822	1,238,930	1,357,623	1,467,470	1,569,813	1,682,822	1,779,531	1,900,052
	Feature phone	445,821	462,249	700,243	787,434	753,276	744,941	733,748	607,400	585,907	550,932	509,211	452,074	408,766
	Smartphone	47,867	55,007	91,376	160,033	280,567	384,881	505,182	750,223	881,563	1,018,881	1,173,612	1,327,457	1,491,286

Source: Jefferies & Co. estimates. Note: actual through 2010

Exhibit 138: Annual Growth of Feature Phones vs. Smartphone Shipments by Region, 2009-2020E

Y/Y Sell-Through	Device Type	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Global	**Total**	**-1%**	**32%**	**9%**	**6%**	**7%**	**7%**	**7%**	**6%**	**6%**	**6%**	**5%**	**6%**
	Feature phone	-4%	25%	0%	-7%	-4%	-4%	-15%	-6%	-8%	-9%	-12%	-11%
	Smartphone	24%	73%	50%	43%	28%	24%	32%	15%	13%	13%	12%	10%
Asia/Pacific ex. Japan	Total	7%	57%	21%	9%	10%	10%	10%	8%	7%	7%	6%	7%
	Feature phone	5%	53%	14%	-4%	-1%	-1%	-17%	-4%	-6%	-8%	-11%	-10%
	Smartphone	34%	95%	83%	86%	40%	34%	52%	18%	16%	16%	14%	13%
Eastern Europe	Total	-17%	31%	4%	5%	6%	7%	7%	7%	7%	7%	7%	6%
	Feature phone	-18%	26%	-2%	-8%	-10%	-8%	-10%	-7%	-7%	-9%	-12%	-8%
	Smartphone	-4%	88%	50%	63%	46%	31%	26%	19%	16%	15%	14%	10%
Latin America	Total	-18%	33%	2%	1%	5%	5%	6%	7%	7%	7%	7%	6%
	Feature phone	-21%	25%	-8%	-7%	-5%	-8%	-6%	-8%	-8%	-7%	-6%	-5%
	Smartphone	94%	142%	80%	37%	31%	32%	24%	22%	18%	15%	13%	11%
Middle East & Africa	Total	-6%	25%	2%	3%	6%	5%	5%	3%	3%	1%	1%	2%
	Feature phone	-7%	21%	-3%	-5%	-6%	-7%	-8%	-9%	-9%	-9%	-10%	-10%
	Smartphone	-3%	55%	44%	45%	42%	33%	25%	17%	12%	7%	7%	8%
Northern America	Total	0%	5%	-2%	4%	3%	3%	3%	2%	3%	3%	3%	2%
	Feature phone	-6%	-13%	-22%	-22%	-17%	-14%	-18%	-19%	-23%	-31%	-36%	-59%
	Smartphone	27%	58%	33%	29%	15%	10%	9%	7%	8%	8%	6%	6%
Western Europe	Total	9%	4%	-6%	2%	2%	3%	2%	2%	2%	3%	5%	3%
	Feature phone	1%	-23%	-38%	-10%	-16%	-12%	-20%	-21%	-20%	-25%	-34%	-59%
	Smartphone	41%	89%	34%	9%	12%	9%	9%	7%	5%	6%	9%	6%
Japan	Total	-17%	1%	1%	3%	2%	2%	2%	3%	3%	2%	2%	3%
	Feature phone	-22%	-1%	-46%	-50%	-74%	-63%	-49%	3%	3%	2%	2%	3%
	Smartphone	-12%	3%	43%	21%	13%	4%	3%	3%	3%	2%	2%	3%
Note:													
Total Europe	Total	0%	12%	-3%	3%	4%	5%	4%	4%	4%	5%	6%	4%
	Feature phone	-6%	-6%	-22%	-9%	-13%	-10%	-14%	-12%	-11%	-14%	-18%	-19%
	Smartphone	33%	89%	36%	17%	19%	15%	14%	11%	9%	10%	11%	7%
Total Asia	Total	5%	53%	20%	9%	9%	10%	10%	8%	7%	7%	6%	7%
	Feature phone	4%	51%	12%	-4%	-1%	-2%	-17%	-4%	-6%	-8%	-11%	-10%
	Smartphone	15%	66%	75%	75%	37%	31%	49%	18%	16%	15%	13%	12%

Source: Jefferies & Co. estimates. Note: actual through 2010

Exhibit 139: Percentage of Feature Phone and Smartphone Shipments by Region, 2008-2020E

% of Global	Device Type	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Asia/Pacific ex. Japan	Feature phone	39%	43%	53%	60%	62%	64%	66%	64%	66%	67%	68%	69%	70%
	Smartphone	20%	22%	25%	30%	39%	42%	46%	53%	54%	56%	57%	58%	59%
Eastern Europe	Feature phone	8%	7%	7%	7%	7%	6%	6%	6%	6%	6%	6%	6%	7%
	Smartphone	5%	4%	4%	4%	5%	6%	6%	6%	6%	6%	6%	6%	6%
Latin America	Feature phone	13%	11%	11%	10%	10%	10%	9%	10%	10%	10%	10%	11%	12%
	Smartphone	3%	4%	6%	7%	7%	7%	7%	7%	7%	8%	8%	8%	8%
Middle East & Africa	Feature phone	11%	11%	11%	10%	10%	10%	10%	11%	10%	10%	10%	10%	10%
	Smartphone	9%	7%	6%	6%	6%	7%	7%	7%	7%	7%	6%	6%	6%
Northern America	Feature phone	14%	13%	9%	7%	6%	5%	5%	5%	4%	3%	2%	2%	1%
	Smartphone	26%	26%	24%	21%	19%	17%	15%	13%	12%	11%	11%	10%	10%
Western Europe	Feature phone	13%	14%	9%	5%	5%	4%	4%	4%	3%	3%	2%	2%	1%
	Smartphone	23%	26%	29%	26%	20%	17%	15%	12%	12%	11%	10%	10%	9%
Japan	Feature phone	2%	2%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Smartphone	14%	10%	6%	6%	5%	4%	4%	3%	2%	2%	2%	2%	2%
Note:														
Total Europe	Feature phone	21%	21%	16%	12%	12%	11%	10%	10%	10%	9%	9%	8%	7%
	Smartphone	28%	30%	33%	30%	25%	23%	21%	18%	17%	17%	16%	16%	16%
Total Asia	Feature phone	41%	44%	54%	61%	62%	64%	66%	64%	66%	67%	68%	69%	70%
	Smartphone	34%	32%	31%	36%	44%	47%	49%	56%	57%	58%	59%	60%	61%

Source: Jefferies & Co. estimates. Note: actual through 2010

Exhibit 140: Mix of Feature Phone and Smartphone Shipments by Region, 2008-2020E

% of Smartphone	Device Type	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	Feature phone	89%	86%	81%	74%	65%	58%	52%	41%	36%	32%	27%	23%	19%
	Smartphone	11%	14%	19%	26%	35%	42%	48%	59%	64%	68%	73%	77%	81%
Asia/Pacific ex. Japan	Feature phone	94%	92%	90%	85%	75%	68%	61%	46%	41%	36%	31%	26%	22%
	Smartphone	6%	8%	10%	15%	25%	32%	39%	54%	59%	64%	69%	74%	78%
Eastern Europe	Feature phone	92%	91%	87%	82%	72%	61%	52%	44%	38%	33%	28%	23%	20%
	Smartphone	8%	9%	13%	18%	28%	39%	48%	56%	62%	67%	72%	77%	80%
Latin America	Feature phone	97%	94%	89%	80%	73%	66%	58%	51%	44%	38%	33%	29%	26%
	Smartphone	3%	6%	11%	20%	27%	34%	42%	49%	56%	62%	67%	71%	74%
Middle East & Africa	Feature phone	91%	90%	88%	83%	76%	68%	60%	53%	46%	41%	37%	33%	29%
	Smartphone	9%	10%	12%	17%	24%	32%	40%	47%	54%	59%	63%	67%	71%
Northern America	Feature phone	80%	75%	62%	49%	37%	30%	25%	20%	16%	12%	8%	5%	2%
	Smartphone	20%	25%	38%	51%	63%	70%	75%	80%	84%	88%	92%	95%	98%
Western Europe	Feature phone	82%	76%	56%	37%	33%	27%	23%	18%	14%	11%	8%	5%	2%
	Smartphone	18%	24%	44%	63%	67%	73%	77%	82%	86%	89%	92%	95%	98%
Japan	Feature phone	51%	48%	47%	26%	13%	3%	1%	1%	1%	1%	1%	1%	1%
	Smartphone	49%	52%	53%	74%	87%	97%	99%	99%	99%	99%	99%	99%	99%
Note:														
Total Europe	Feature phone	85%	81%	67%	54%	48%	40%	35%	28%	24%	20%	17%	13%	10%
	Smartphone	15%	19%	33%	46%	52%	60%	65%	72%	76%	80%	83%	87%	90%
Total Asia	Feature phone	90%	89%	88%	83%	73%	66%	59%	45%	40%	35%	30%	25%	22%
	Smartphone	10%	11%	12%	17%	27%	34%	41%	55%	60%	65%	70%	75%	78%

Source: Jefferies & Co. estimates.   Note: actual through 2010

Exhibit 141: Mobile Subscribers by Region and Technology, 2008-2020E

(Subscribers, K)	Generation	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Global	**Total**	**3,951,653**	**4,573,763**	**5,113,540**	**5,375,203**	**5,577,741**	**5,767,007**	**5,895,087**	**6,026,193**	**6,329,546**	**6,621,057**	**6,927,254**	**7,228,494**	**7,597,822**
	2G	3,261,755	3,703,714	3,962,350	3,928,491	3,768,777	3,532,606	3,290,611	3,021,436	2,691,768	2,356,500	2,036,865	1,740,977	1,497,905
	3G	689,898	870,049	1,150,008	1,438,295	1,776,386	2,126,938	2,401,208	2,668,547	3,045,826	3,352,531	3,688,719	3,970,038	4,287,101
	4G	0	0	1,182	8,417	32,577	107,463	203,268	336,210	591,951	912,027	1,201,670	1,517,479	1,812,817
Asia-Pacifc ex. Japan	Total	1,584,071	1,957,884	2,269,411	2,443,520	2,591,172	2,696,710	2,782,000	2,869,494	3,100,022	3,337,306	3,587,378	3,844,237	4,168,418
	2G	1,382,753	1,670,163	1,877,359	1,933,680	1,953,017	1,894,426	1,780,761	1,629,396	1,384,987	1,101,064	814,788	562,203	337,322
	3G	201,318	287,721	392,046	509,660	637,075	796,344	971,540	1,165,848	1,492,285	1,790,742	2,148,890	2,471,224	2,841,908
	4G	0	0	5	180	1,080	5,940	29,700	74,250	222,750	445,500	623,700	810,810	989,188
Eastern Europe	Total	443,091	476,794	514,190	519,122	518,686	520,039	519,951	522,385	521,020	520,398	522,021	519,856	520,600
	2G	427,197	445,066	433,745	390,370	331,815	265,452	209,707	146,795	85,141	42,570	17,028	6,811	2,725
	3G	15,894	31,728	80,445	128,712	186,632	251,954	302,344	359,790	413,758	446,859	464,733	464,733	464,733
	4G	0	0	0	40	239	2,633	7,900	15,800	22,121	30,969	40,259	48,311	53,142
Latin America	Total	448,474	512,595	555,548	573,500	588,890	646,785	674,345	698,837	714,969	730,291	745,642	762,821	774,993
	2G	394,875	466,372	499,662	489,669	454,662	431,928	411,468	391,977	364,538	347,270	330,820	297,738	283,634
	3G	53,599	46,223	55,886	83,829	134,126	214,602	257,522	296,151	331,689	354,907	372,652	391,285	399,110
	4G	0	0	0	2	102	255	5,355	10,710	18,743	28,114	42,171	73,799	92,248
Middle East & Africa	Total	581,175	696,943	782,982	845,041	883,488	911,579	939,000	967,563	1,001,128	1,031,239	1,068,763	1,100,093	1,129,388
	2G	559,323	664,026	732,071	768,674	791,734	807,569	823,721	840,195	856,999	865,569	874,225	874,225	874,225
	3G	21,852	32,917	50,911	76,366	91,640	103,553	113,908	121,882	130,413	138,238	146,532	153,859	161,552
	4G	0	0	0	0	114	457	1,372	5,486	13,716	27,432	48,006	72,009	93,612
Northern America	Total	287,857	305,116	326,585	329,482	337,467	343,193	346,266	351,120	358,459	365,395	373,898	377,939	385,501
	2G	108,956	85,063	63,260	44,282	26,569	6,642	1,661	415	104	26	5	0	0
	3G	178,901	220,052	262,509	278,259	286,607	263,678	242,584	223,177	205,323	184,791	162,616	134,971	101,228
	4G	0	0	817	6,940	24,291	72,873	102,022	127,527	153,033	180,578	211,277	242,968	284,273
Western Europe	Total	503,640	516,720	553,179	549,559	540,659	528,531	511,436	492,381	506,264	506,195	497,024	488,771	481,840
	2G	379,608	369,135	354,590	301,401	210,981	126,589	63,294	12,659	0	0	0	0	0
	3G	124,033	147,585	198,274	247,842	327,151	389,310	416,562	416,562	395,734	368,032	331,229	298,106	268,296
	4G	0	0	316	316	2,526	12,632	31,580	63,160	110,530	138,163	165,795	190,664	213,544
Japan	Total	103,346	107,711	111,646	114,980	117,379	120,169	122,087	124,414	127,683	130,233	132,527	134,776	137,082
	2G	9,044	3,888	1,664	414	0	0	0	0	0	0	0	0	0
	3G	94,302	103,823	109,938	113,627	113,155	107,497	96,747	85,138	76,624	68,961	62,065	55,859	50,273
	4G	0	0	45	939	4,224	12,672	25,340	39,277	51,060	61,271	70,462	78,918	86,809
Note:														
Total Europe	Total	946,731	993,514	1,067,369	1,068,681	1,059,345	1,048,570	1,031,388	1,014,766	1,027,284	1,026,593	1,019,045	1,008,627	1,002,440
	2G	806,805	814,201	788,334	691,771	542,795	392,040	273,001	159,454	85,141	42,570	17,028	6,811	2,725
	3G	139,927	179,313	278,719	376,554	513,784	641,264	718,906	776,352	809,492	814,892	795,963	762,840	733,029
	4G	0	0	316	356	2,766	15,265	39,480	78,960	132,651	169,131	206,054	238,976	266,686
Total Asia	Total	1,687,417	2,065,595	2,381,057	2,558,500	2,708,551	2,816,880	2,904,087	2,993,908	3,227,705	3,467,539	3,719,906	3,979,014	4,305,500
	2G	1,391,797	1,674,052	1,879,023	1,934,094	1,953,017	1,894,426	1,780,761	1,629,396	1,384,987	1,101,064	814,788	562,203	337,322
	3G	295,620	391,544	501,984	623,287	750,230	903,841	1,068,287	1,250,985	1,568,909	1,859,703	2,210,956	2,527,083	2,892,181
	4G	0	0	50	1,119	5,304	18,612	55,040	113,527	273,810	506,771	694,162	889,728	1,075,998

Source: Jefferies & Co. estimates.   Note: actual through 2010

Exhibit 142: Annual Growth of Mobile Subscribers by Region and Technology, 2008-2020E

Y/Y Sub Growth	Generation	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Global	**Total**	**20%**	**16%**	**12%**	**5%**	**4%**	**3%**	**2%**	**2%**	**5%**	**5%**	**5%**	**4%**	**5%**
	2G	19%	14%	7%	-1%	-4%	-6%	-7%	-8%	-11%	-12%	-14%	-15%	-14%
	3G	21%	26%	32%	25%	24%	20%	13%	11%	14%	10%	10%	8%	8%
	4G				612%	287%	230%	89%	65%	76%	54%	32%	26%	19%
Asia-Pacifc ex. Japan	Total	28%	24%	16%	8%	6%	4%	3%	3%	8%	8%	7%	7%	8%
	2G	28%	21%	12%	3%	1%	-3%	-6%	-9%	-15%	-21%	-26%	-31%	-40%
	3G	26%	43%	36%	30%	25%	25%	22%	20%	28%	20%	20%	15%	15%
	4G				3500%	500%	450%	400%	150%	200%	100%	40%	30%	22%
Eastern Europe	Total	14%	8%	8%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	2G	12%	4%	-3%	-10%	-15%	-20%	-21%	-30%	-42%	-50%	-60%	-60%	-60%
	3G	178%	100%	154%	60%	45%	35%	20%	19%	15%	8%	4%	0%	0%
	4G					500%	1000%	200%	100%	40%	40%	30%	20%	10%
Latin America	Total	19%	14%	8%	3%	3%	10%	4%	4%	2%	2%	2%	2%	2%
	2G	29%	18%	7%	-2%	-7%	-5%	-5%	-5%	-7%	-5%	-5%	-10%	-5%
	3G	-23%	-14%	21%	50%	60%	60%	20%	15%	12%	7%	5%	5%	2%
	4G					5000%	150%	2000%	100%	75%	50%	50%	75%	25%
Middle East & Africa	Total	28%	20%	12%	8%	5%	3%	3%	3%	3%	3%	4%	3%	3%
	2G	27%	19%	10%	5%	3%	2%	2%	2%	2%	1%	1%	0%	0%
	3G	80%	51%	55%	50%	20%	13%	10%	7%	7%	6%	6%	5%	5%
	4G						300%	200%	300%	150%	100%	75%	50%	30%
Northern America	Total	6%	6%	7%	1%	2%	2%	1%	1%	2%	2%	2%	1%	2%
	2G	-10%	-22%	-26%	-30%	-40%	-75%	-75%	-75%	-75%	-75%	-80%	-100%	
	3G	18%	23%	19%	6%	3%	-8%	-8%	-8%	-8%	-10%	-12%	-17%	-25%
	4G				750%	250%	200%	40%	25%	20%	18%	17%	15%	17%
Western Europe	Total	6%	3%	7%	-1%	-2%	-2%	-3%	-4%	3%	0%	-2%	-2%	-1%
	2G	-2%	-3%	-4%	-15%	-30%	-40%	-50%	-80%	-100%				
	3G	40%	19%	34%	25%	32%	19%	7%	0%	-5%	-7%	-10%	-10%	-10%
	4G				0%	700%	400%	150%	100%	75%	25%	20%	15%	12%
Japan	Total	5%	4%	4%	3%	2%	2%	2%	2%	3%	2%	2%	2%	2%
	2G	-45%	-57%	-57%	-75%	-100%								
	3G	15%	10%	6%	3%	0%	-5%	-10%	-12%	-10%	-10%	-10%	-10%	-10%
	4G				2000%	350%	200%	100%	55%	30%	20%	15%	12%	10%
Note:														
Total Europe	Total	95%	5%	7%	0%	-1%	-1%	-2%	-2%	1%	0%	-1%	-1%	-1%
	2G	102%	1%	-3%	-12%	-22%	-28%	-30%	-42%	-47%	-50%	-60%	-60%	-60%
	3G	60%	28%	55%	35%	36%	25%	12%	8%	4%	1%	-2%	-4%	-4%
	4G				13%	678%	452%	159%	100%	68%	28%	22%	16%	12%
Total Asia	Total	26%	22%	15%	7%	6%	4%	3%	3%	8%	7%	7%	7%	8%
	2G	27%	20%	12%	3%	1%	-3%	-6%	-9%	-15%	-21%	-26%	-31%	-40%
	3G	22%	32%	28%	24%	20%	20%	18%	17%	25%	19%	19%	14%	14%
	4G				2151%	374%	251%	196%	106%	141%	85%	37%	28%	21%

Source: Jefferies & Co. estimates.   Note: actual through 2010

Exhibit 143: Percentage of Mobile Subscribers by Region and Technology, 2008-2020E

% of Global	Generation	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Asia-Pacifc ex. Japan	Total	40%	43%	44%	45%	46%	47%	47%	48%	49%	50%	52%	53%	55%
	2G	42%	45%	47%	49%	52%	54%	54%	54%	51%	47%	40%	32%	23%
	3G	29%	33%	34%	35%	36%	37%	40%	44%	49%	53%	58%	62%	66%
	4G			0%	2%	3%	6%	15%	22%	38%	49%	52%	53%	55%
Eastern Europe	Total	11%	10%	10%	10%	9%	9%	9%	9%	8%	8%	8%	7%	7%
	2G	13%	12%	11%	10%	9%	8%	6%	5%	3%	2%	1%	0%	0%
	3G	2%	4%	7%	9%	11%	12%	13%	13%	14%	13%	13%	12%	11%
	4G			0%	0%	1%	2%	4%	5%	4%	3%	3%	3%	3%
Latin America	Total	11%	11%	11%	11%	11%	11%	11%	12%	11%	11%	11%	11%	10%
	2G	12%	13%	13%	12%	12%	12%	13%	13%	14%	15%	16%	17%	19%
	3G	8%	5%	5%	6%	8%	10%	11%	11%	11%	11%	10%	10%	9%
	4G			0%	0%	0%	0%	3%	3%	3%	3%	4%	5%	5%
Middle East & Africa	Total	15%	15%	15%	16%	16%	16%	16%	16%	16%	16%	15%	15%	15%
	2G	17%	18%	18%	20%	21%	23%	25%	28%	32%	37%	43%	50%	58%
	3G	3%	4%	4%	5%	5%	5%	5%	5%	4%	4%	4%	4%	4%
	4G			0%	0%	0%	0%	1%	2%	2%	3%	4%	5%	5%
Northern America	Total	7%	7%	6%	6%	6%	6%	6%	6%	6%	6%	5%	5%	5%
	2G	3%	2%	2%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%
	3G	26%	25%	23%	19%	16%	12%	10%	8%	7%	6%	4%	3%	2%
	4G			69%	82%	75%	68%	50%	38%	26%	20%	18%	16%	16%
Western Europe	Total	13%	11%	11%	10%	10%	9%	9%	8%	8%	8%	7%	7%	6%
	2G	12%	10%	9%	8%	6%	4%	2%	0%	0%	0%	0%	0%	0%
	3G	18%	17%	17%	17%	18%	18%	17%	16%	13%	11%	9%	8%	6%
	4G			27%	4%	8%	12%	16%	19%	19%	15%	14%	13%	12%
Japan	Total	3%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
	2G	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	3G	14%	12%	10%	8%	6%	5%	4%	3%	3%	2%	2%	1%	1%
	4G			4%	11%	13%	12%	12%	12%	9%	7%	6%	5%	5%
Note:														
Total Europe	Total	24%	22%	21%	20%	19%	18%	17%	17%	16%	16%	15%	14%	13%
	2G	25%	22%	20%	18%	14%	11%	8%	5%	3%	2%	1%	0%	0%
	3G	20%	21%	24%	26%	29%	30%	30%	29%	27%	24%	22%	19%	17%
	4G			27%	4%	8%	14%	19%	23%	22%	19%	17%	16%	15%
Total Asia	Total	43%	45%	47%	48%	49%	49%	49%	50%	51%	52%	54%	55%	57%
	2G	43%	45%	47%	49%	52%	54%	54%	54%	51%	47%	40%	32%	23%
	3G	43%	45%	44%	43%	42%	42%	44%	47%	52%	55%	60%	64%	67%
	4G			4%	13%	16%	17%	27%	34%	46%	56%	58%	59%	59%

Source: Jefferies & Co. estimates. Note: actual through 2010

Exhibit 144: Technology Mix of Mobile Subscribers by Region and Technology, 2008-2020E

% of 2G-3G-4G	Generation	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Global	2G	83%	81%	77%	73%	68%	61%	56%	50%	43%	36%	29%	24%	20%
	3G	17%	19%	22%	27%	32%	37%	41%	44%	48%	51%	53%	55%	56%
	4G	0%	0%	0%	0%	1%	2%	3%	6%	9%	14%	17%	21%	24%
Asia-Pacifc ex. Japan	2G	87%	85%	83%	79%	75%	70%	64%	57%	45%	33%	23%	15%	8%
	3G	13%	15%	17%	21%	25%	30%	35%	41%	48%	54%	60%	64%	68%
	4G	0%	0%	0%	0%	0%	0%	1%	3%	7%	13%	17%	21%	24%
Eastern Europe	2G	96%	93%	84%	75%	64%	51%	40%	28%	16%	8%	3%	1%	1%
	3G	4%	7%	16%	25%	36%	48%	58%	69%	79%	86%	89%	89%	89%
	4G	0%	0%	0%	0%	0%	1%	2%	3%	4%	6%	8%	9%	10%
Latin America	2G	88%	91%	90%	85%	77%	67%	61%	56%	51%	48%	44%	39%	37%
	3G	12%	9%	10%	15%	23%	33%	38%	42%	46%	49%	50%	51%	51%
	4G	0%	0%	0%	0%	0%	0%	1%	2%	3%	4%	6%	10%	12%
Middle East & Africa	2G	96%	95%	93%	91%	90%	89%	88%	87%	86%	84%	82%	79%	77%
	3G	4%	5%	7%	9%	10%	11%	12%	13%	13%	13%	14%	14%	14%
	4G	0%	0%	0%	0%	0%	0%	0%	1%	1%	3%	4%	7%	8%
Northern America	2G	38%	28%	19%	13%	8%	2%	0%	0%	0%	0%	0%	0%	0%
	3G	62%	72%	80%	84%	85%	77%	70%	64%	57%	51%	43%	36%	26%
	4G	0%	0%	0%	2%	7%	21%	29%	36%	43%	49%	57%	64%	74%
Western Europe	2G	75%	71%	64%	55%	39%	24%	12%	3%	0%	0%	0%	0%	0%
	3G	25%	29%	36%	45%	61%	74%	81%	85%	78%	73%	67%	61%	56%
	4G	0%	0%	0%	0%	0%	2%	6%	13%	22%	27%	33%	39%	44%
Japan	2G	9%	4%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	3G	91%	96%	98%	99%	96%	89%	79%	68%	60%	53%	47%	41%	37%
	4G	0%	0%	0%	1%	4%	11%	21%	32%	40%	47%	53%	59%	63%
Note:														
Total Europe	2G	85%	82%	74%	65%	51%	37%	26%	16%	8%	4%	2%	1%	0%
	3G	15%	18%	26%	35%	49%	61%	70%	77%	79%	79%	78%	76%	73%
	4G	0%	0%	0%	0%	0%	1%	4%	8%	13%	16%	20%	24%	27%
Total Asia	2G	82%	81%	79%	76%	72%	67%	61%	54%	43%	32%	22%	14%	8%
	3G	18%	19%	21%	24%	28%	32%	37%	42%	49%	54%	59%	64%	67%
	4G	0%	0%	0%	0%	0%	1%	2%	4%	8%	15%	19%	22%	25%

Source: Jefferies & Co. estimates.   Note: actual through 2010

Exhibit 145: Wireless Penetration by Region and Technology, 2008-2020E

Wireless Penetration	**Generation**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Global		**66%**	**76%**	**84%**	**87%**	**90%**	**92%**	**93%**	**94%**	**95%**	**96%**	**97%**	**98%**	**99%**
	2G	55%	61%	65%	64%	61%	56%	52%	47%	41%	34%	28%	24%	20%
	3G	12%	14%	19%	23%	29%	34%	38%	42%	46%	49%	52%	54%	56%
	4G	0%	0%	0%	0%	1%	2%	3%	5%	9%	13%	17%	20%	24%
Asia-Pacifc ex. Japan	Total	54%	66%	76%	81%	86%	89%	91%	93%	94%	95%	97%	98%	101%
	2G	47%	56%	63%	64%	65%	62%	58%	53%	42%	31%	22%	14%	8%
	3G	7%	10%	13%	17%	21%	26%	32%	38%	45%	51%	58%	63%	69%
	4G	0%	0%	0%	0%	0%	0%	1%	2%	7%	13%	17%	21%	24%
Eastern Europe	Total	135%	146%	158%	159%	160%	160%	160%	161%	161%	161%	162%	162%	162%
	2G	131%	136%	133%	120%	102%	82%	65%	45%	26%	13%	5%	2%	1%
	3G	5%	10%	25%	40%	57%	78%	93%	111%	128%	138%	144%	144%	145%
	4G	0%	0%	0%	0%	0%	1%	2%	5%	7%	10%	12%	15%	17%
Latin America	Total	78%	88%	94%	96%	98%	106%	109%	112%	114%	115%	116%	118%	119%
	2G	68%	80%	85%	82%	75%	71%	67%	63%	58%	55%	52%	46%	43%
	3G	9%	8%	9%	14%	22%	35%	42%	48%	53%	56%	58%	61%	61%
	4G	0%	0%	0%	0%	0%	0%	1%	2%	3%	4%	7%	11%	14%
Middle East & Africa	Total	46%	54%	60%	63%	64%	65%	66%	66%	67%	68%	69%	69%	70%
	2G	45%	52%	56%	57%	58%	58%	58%	58%	57%	57%	56%	55%	54%
	3G	2%	3%	4%	6%	7%	7%	8%	8%	9%	9%	9%	10%	10%
	4G	0%	0%	0%	0%	0%	0%	0%	0%	1%	2%	3%	5%	6%
Northern America	Total	85%	89%	95%	95%	96%	97%	97%	98%	99%	100%	101%	102%	103%
	2G	32%	25%	18%	13%	8%	2%	0%	0%	0%	0%	0%	0%	0%
	3G	53%	64%	76%	80%	82%	75%	68%	62%	57%	51%	44%	36%	27%
	4G	0%	0%	0%	2%	7%	21%	29%	35%	42%	49%	57%	65%	76%
Western Europe	Total	122%	125%	133%	132%	129%	126%	122%	117%	120%	119%	117%	115%	113%
	2G	92%	89%	85%	72%	50%	30%	15%	3%	0%	0%	0%	0%	0%
	3G	30%	36%	48%	59%	78%	93%	99%	99%	94%	87%	78%	70%	63%
	4G	0%	0%	0%	0%	1%	3%	8%	15%	26%	33%	39%	45%	50%
Japan	Total	82%	85%	88%	91%	93%	95%	97%	99%	101%	104%	106%	108%	110%
	2G	7%	3%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	3G	75%	82%	87%	90%	90%	85%	77%	68%	61%	55%	50%	45%	40%
	4G	0%	0%	0%	1%	3%	10%	20%	31%	41%	49%	56%	63%	70%
Note:														
Total Europe	Total	128%	134%	144%	144%	143%	141%	138%	136%	138%	137%	136%	135%	134%
	2G	109%	110%	106%	93%	73%	53%	37%	21%	11%	6%	2%	1%	0%
	3G	19%	24%	38%	51%	69%	86%	97%	104%	108%	109%	106%	102%	98%
	4G	0%	0%	0%	0%	0%	2%	5%	11%	18%	23%	28%	32%	36%
Total Asia	Total	55%	67%	76%	82%	86%	89%	91%	93%	94%	96%	97%	98%	101%
	2G	45%	54%	60%	62%	62%	60%	56%	51%	41%	30%	21%	14%	8%
	3G	10%	13%	16%	20%	24%	29%	34%	39%	46%	51%	58%	62%	68%
	4G	0%	0%	0%	0%	0%	1%	2%	4%	8%	14%	18%	22%	25%

Source: Jefferies & Co. estimates. Note: actual through 2010

Analyst Certification

I, Cynthia Meng, certify that all of the views expressed in this research report accurately reflect my personal views about the subject security(ies) and subject company(ies). I also certify that no part of my compensation was, is, or will be, directly or indirectly, related to the specific recommendations or views expressed in this research report.

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Other Companies Mentioned in This Report

- AAC Technologies Holdings Inc. (2018 HK: HK$16.64, BUY)
- Adobe Systems Inc. (ADBE: $25.24, BUY)
- Advanced Micro Devices, Inc. (AMD: $6.83, HOLD)
- Alcatel Lucent (ALU FP: €2.62, BUY)
- Altera Corp (ALTR: $36.39, BUY)
- Amazon.com, Inc (AMZN: $215.23, BUY)
- Antena3 (A3TV SM: €4.93, UNDERPERFORM)
- Apple Inc. (AAPL: $384.83, BUY)
- ARM Holdings plc (ARM LN: p566.00, UNDERPERFORM)
- ASM International N.V. (ASM NA: €18.68, HOLD)
- ASML Holding NV (ASML NA: €24.45, BUY)
- Avago Technologies (AVGO: $33.11, BUY)
- Best Buy Company, Inc. (BBY: $25.59, HOLD)
- Broadcom Corporation (BRCM: $35.65, BUY)
- Broadsoft, Inc. (BSFT: $30.25, BUY)
- BSkyB (BSY LN: p695.50, HOLD)
- China Mobile Limited (941 HK: HK$79.95, HOLD)
- China Telecom Corp Ltd. (728 HK: HK$5.12, BUY)
- China Unicom (Hong Kong) Ltd. (762 HK: CNY16.28, BUY)
- Cisco Systems, Inc. (CSCO: $15.67, HOLD)
- Concur Technologies, Inc. (CNQR: $41.82, BUY)
- Dialog Semiconductor plc (DLG GR: €13.57, BUY)
- eBay, Inc. (EBAY: $30.87, BUY)
- Expedia, Inc (EXPE: $30.31, BUY)
- France Telecom SA (FTE FP: €13.49, UNDERPERFORM)
- Google, Inc. (GOOG: $540.96, BUY)
- Hewlett-Packard (HPQ: $26.03, BUY)
- Imagination Technologies (IMG LN: p356.80, BUY)
- Inphi Corporation (IPHI: $8.04, BUY)
- Intel Corporation (INTC: $20.13, HOLD)
- Intuit Inc. (INTU: $49.33, BUY)
- ITV (ITV LN: p59.70, HOLD)
- Juniper, Inc. (JNPR: $20.93, BUY)
- MasterCard, Inc. (MA: $329.71, BUY)
- Micro Focus (MCRO LN: p310.70, HOLD)
- Murata Manufacturing (6981 JP: ¥4,680, BUY)
- Netflix, Inc. (NFLX: $235.01, HOLD)
- NetLogic Microsystems, Inc. (NETL: $30.02, BUY)
- NXP Semiconductors NV (NXPI: $16.29, BUY)
- Orbitz Worldwide, Inc. (OWW: $2.54, HOLD)
- PMC-Sierra, Inc. (PMCS: $6.09, BUY)
- Qlik Technologies (QLIK: $25.38, HOLD)
- Research in Motion, Inc. (RIMM: $32.49, HOLD)
- Salesforce.com (CRM: $128.75, BUY)
- SAP AG (SAP: $54.51, HOLD)
- Sierra Wireless (SWIR: $7.30, HOLD)
- Symantec Corp. (SYMC: $17.15, BUY)
- Target Corp. (TGT: $51.67, HOLD)
- Tekelec (TKLC: $7.20, HOLD)
- Telecinco (TL5 SM: €5.00, BUY)
- TelecityGroup (TCY LN: p572.50, HOLD)
- TeliaSonera (TLSN SS: SEK46.14, UNDERPERFORM)
- Visa, Inc. (V: $87.88, BUY)
- Vodafone plc (VOD LN: p164.40, BUY)

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Rating	Count	Percent	IB Serv./Past 12 Mos. Count	IB Serv./Past 12 Mos. Percent
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HOLD	525	41.90%	31	5.90%
UNDERPERFORM	62	4.90%	2	3.23%

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